GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

ELG

Date: January 28, 1977

Project Title: Design of a Low Cost Earth Resources System

Project No: A-1938

Project Director: Mr. N. L. Faust

Sponsor: NASA, George C. Marshall Space Flight Center, Alabama 35812

Agreement Period: From 1/13/77 Until 1/12/78 (Contr. Period)

Type Agreement: Contract No. NAS8-32397

Amount: $24,827 NASA + $1,000 GIT Contribution

Reports Required: Monthly Progress Reports; Final Report

Sponsor Contact Person (s):

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Contracting Officer Rep. NASA - Marshall Space Flight Center Alabama 35812	ONR Resident Representative 325 Hinman Research Building Campus

Defense Priority Rating: CO-C9 under DMS Reg. 1.

Assigned to: Electromagnetics Laboratory (School/Laboratory)

COPIES TO:

Project Director	Library, Technical Reports Section
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CA–3 (3/76)

Posted 10/28 OB

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 10/19/78 OHL

Project Title: Design of a Low Cost Earth Resources System

Project No: A-1938

Project Director: Mr. N. L. Faust

Sponsor: NASA, George C. Marshall Space Flight Center, AL 35812

Effective Termination Date: 5/31/78(Contract Expiration)

Clearance of Accounting Charges: by 5/31/78

Grant/Contract Closeout Actions Remaining:

- x Final Invoice and Closing Documents
- _ Final Fiscal Report
- _ Final Report of Inventions
- X Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- X Other Subcontract Closeout

Assigned to: Electromagnetics Laboratory (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
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Reports Coordinator (OCA)

Library, Technical Reports Section
Office of Computing Services
Director, Physical Plant
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other K. E. Newkirk

CA—4 (3/76)

Monthly Progress Reports No. 1 and 2

For the Period January 13, 1977 through February 28, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397

(A-1938)

1 April 1977

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. INTRODUCTION

State and local government agencies, and private industry in Georgia and throughout the Nation are becoming increasingly aware of the advantages of digital processing of LANDSAT data. In the last several years the technical interest in the digital processing techniques of LANDSAT data has evolved from the "gee whiz" stage to the practical adaptation stage. Many agencies at least at the State level have the technical capability and the professional interest needed to operate an earth resources digital analysis system with the technical assistance of universities or private industry. To date, however, very little progress has been made in the transfer of the digital processing capability from NASA to user agencies. This failure is in part due to the complexity of the techniques used to analyze LANDSAT data and also in part due to the prohibitive costs associated with designing an Earth Resources Digital Analysis System (ERDAS). The Georgia Tech Engineering Experiment Station (EES) has designed and made operational a practical ERDAS system at Georgia Tech. The experience gained in the design of such a system is a valuable asset in the design of more efficient and less expensive versions of an ERDAS system that may become a necessary part of a regional, state or local LANDSAT applications program. Judicious choice of the most cost effective equipment and the most usable software will be necessary to justify the operational application of LANDSAT information.

The State of Georgia is on the threshold of approving the statewide, digital processing of LANDSAT data on the Georgia Tech ERDAS system. Many state agencies including the Department of Natural Resources, Department of Transportation, and the Office of Planning and Budget are beginning to realize that digital LANDSAT data is the only available data source that will meet both accuracy and timing considerations in the accomplishment of federal and state regional natural resource related programs.

A genuine interest is now being shown by most LANDSAT users including the LANDSAT information into an efficient data base manipulation system such as the IMGRID system developed at Harvard. This system is operationally efficient and is specifically designed for the layman. A keywork structure is used to access program options which interact with the data base. This type of analysis capability will enhance the value of LANDSAT digital data by combining it with other natural resource, economic, and political sources of data. In fact, any type of data that can be geographically referenced may be inserted into the data base and used later

H-1438

Monthly Progress Report No. 3

For the Period March 1, 1977 through March 31, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. INTRODUCTION

EES plans to document requirements for the assembly of a low cost Earth Resources Digital Analysis System (ERDAS). The tasks under this project call for:

1) A review of existing software and hardware capabilities in the southeast.
2) A description of various hardware and software configurations
3) An estimate of continuing support requirements for an ERDAS system
4) The assembly of a FORTRAN software library for digital processing of LANDSAT data in an ERDAS system, and
5) The implementation of a limited version of a geographic data base manipulation program (IMGRID).

II. TECHNICAL PROGRESS SUMMARY

During this period EES continued investigations into the implementation of IMGRID on the NOVA II minicomputer system. Also during this period EES was able to determine a cost figure for the ERDAS system by comparing the amount of time a program needed on the NOVA to the cost of a duplicate program on the Georgia Tech CYBER 74 using identical data and peripheral devices. The cost figure arrived at was approximately ten dollars per hour for the NOVA excluding manpower costs. Other test programs and data sets will be used to verify the preliminary cost data.

Further development was also done on software development and documentation for the ERDAS system.

A subcontract was worked out with METRICS, Inc. for the part of the contract associated with evaluating the present digital analysis capability in the Southeast for processing LANDSAT data.

III. PROBLEMS

There were no new problems encountered during this period.

IV. WORK PLANNED FOR NEXT PERIOD

During the next period, EES plans to finalize the terms of the subcontract with METRICS, Inc. and ask for authorization from MSFC. Further work will be done on software documentation and IMGRID implementation. Further computer runs will be made to verify the preliminary cost figures for the ERDAS system.

V. BUDGET

	BUDGET	EXPENDED	FREE
Technical Services	$23,327	$6,397	$16,930
Materials & Supplies	1,200	354	846
Travel	300	0	300
TOTAL	$24,827	$6,751	$18,076

A 1930

Monthly Progress Report No. 4

For the Period April 1, 1977 through April 30, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. INTRODUCTION

EES plans to document requirements for the assembly of a low cost Earth Resources Digital Analysis System (ERDAS). The tasks under this project call for:

1) A review of existing software and hardware capabilities in the southeast.
2) A description of various hardware and software configurations
3) An estimate of continuing support requirements for an ERDAS system
4) The assembly of a FORTRAN software library for digital processing of LANDSAT data in an ERDAS system, and
5) The implementation of a limited version of a geographic data base manipulation program (IMGRID).

II. TECHNICAL PROGRESS SUMMARY

During this period tasks have been assigned to Metrics, Inc. for their portion of the project. EES has also spent time on the development of packing and unpacking software which will allow IMGRID to be implemented on a minicomputer. Software documentation also is progressing. Earlier cost estimates as to the operational cost of ERDAS seem to be comparing favorably with current costs. A hardware failure during this period, however, gave us limited time on the ERDAS system.

III. PROBLEMS

Two memory board failures occurred on the two 16K NOVA boards. These were repaired, but down time was approximately one week.

IV. WORK PLANNED FOR THE NEXT PERIOD

EES plans to document more software during the next month and to exercise IMGRID with packing and unpacking options on the CDC in preparation for the transfer to the NOVA. Metrics, Inc. should begin a survey in the southeast for digital processing capability for LANDSAT data.

V. BUDGET

	BUDGET	EXPENDED	FREE
Technical Services	$23,327	$6,483	$16,844
Materials & Supplies	1,200	422	778
Travel	300	416	(116)
TOTAL	$24,827	$7,321	$17,506

Monthly Progress Report No. 5

For the Period May 1, 1977 through May 31, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397

(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period EES continued development of a minicomputer version of the IMGRID data base management system. Separate overlays will be necessary to allow the full range of options for the programs. A limited data base will be used for this version of IMGRID because of core constraints. Packing of 2 data words to a 16 bit word will be implemented to double the size of the available data base at the expense of cpu time for packing and unpacking.

Documentation of EES earth resources ERDAS programs is proceeding with internal program comments providing most of the information.

The subcontract to METRICS, INC. is now underway. They are now determining what earth resources digital analysis systems are currently available in the public domain.

II. PROBLEMS

There were no significant problems during this period.

III. WORK PLANNED FOR NEXT PERIOD

EES plans to restructure IMGRID in subroutines to allow overlay capability during June. Packing and unpacking logic for IMGRID will be implemented on the ERDAS system. Further documentation and program development will occur during the next period.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$8,073	$15,254
M & S	1,200	491	709
Travel	300	337	(37)
TOTAL	$24,827	$8,901	$15,926

H-1438

Monthly Progress Report No. 6
For the Period June 1, 1977 through June 30, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. FAUST

Contract No. NAS8-32397
(A-1938)

Prepared for
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period work was continued on the documentation of the ERDAS system software. Much of this documentation will be comment statements inside the computer programs themselves. The IMGRID system is almost ready for transfer to the NOVA minicomputer. The original program has been rewritten in a set of subroutines that may be used as overlays in the NOVA system. All of the primary functions of the new version are being verified by comparison to the old version of IMGRID. Metrics, Inc. is set to begin on their part of the project.

II. PROBLEMS

No new problems were encountered this period.

III. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$ 9,447	$13,880
Materials & Supplies	1,200	550	650
Travel	300	337	(37)
TOTAL	$24,827	$10,334	$14,493

H-1438

Monthly Progress Report No. 7

For the Period July 1, 1977 through July 31, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period operation of the rewritten IMGRID program was verified on the CYBER and was transferred to a NOVA disk for implementation. This version of IMGRID is amenable to overlaying on the NOVA system. Work was also continued on documentation of earth resources software on the NOVA. METRICS, INC. made preparations to initiate their survey of existing hardware and software within the southeastern United States. Several hardware configurations are being considered for prototype low-cost systems. Support requirements for the ERDAS system are being compiled.

II. PROBLEMS

No technical problems were encountered.

III. WORK PLANNED FOR NEXT PERIOD

EES plans to work on implementation of IMGRID on the ERDAS system. Further efforts will be directed at the software documentation. METRICS, INC. will begin their hardware-software survey in ernest.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$12,337	$10,990
Material & Supplies	1,200	661	539
Travel	300	423	(123)
TOTAL	$24,827	$13,421	$11,406

H-1938

Monthly Progress Report No. 8

For the Period August 1, 1977 through August 31, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period a final estimate for cost of NOVA CPU time was determined, and continuing support requirements for the ERDAS system are being compiled. Flecs indented listings of all earth resources programs on the ERDAS system were produced. Efforts continued on the design of an ERDAS system using more powerful minicomputers. Initial work was performed on implementation of the IMGRID system on the NOVA.

II. PROBLEMS

No new technical problems occurred during this period.

III. WORK PLANNED FOR NEXT PERIOD

Further work will be done on implementation of IMGRID. Software documentation, including flowcharts, will continue. The hardware-software survey should have preliminary results by the end of next period.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$13,852	$9,475
Material & Supplies	1,200	2,812	(1,612)
Travel	300	427	(127)
TOTAL	$24,827	$17,091	$7,736

A-1938

Monthly Progress Report No. 9

For the Period September 1, 1977 through September 30, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No.NAS8-32397

(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period effort was put into testing the IMGRID algorithm on the NOVA. Sizing of the program will definitely be a problem. The overlaying of the program is not as easy as we anticipated. A sample data set of data was also transferred to the NOVA during this period. Documentation is proceeding at a low rate. Metrics is gathering material for hardware and software components for a low cost system.

II. PROBLEMS

No technical problems were encountered.

III. WORK PLANNED FOR NEXT PERIOD

EES will continue its attempts to overlay IMGRID on the NOVA. Work is continuing both at EES and Metrics on gathering cost and system parameters for candidate systems.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,797	$ 8,530
Material & Supplies	1,200	2,840	(1,640)
Travel	300	427	(127)
TOTAL	$24,827	$18,064	$ 6,763

Monthly Progress Report No. 10

For the Period October 1, 1977 through October 31, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period efforts at overlaying IMGRID on the NOVA were continued, but it is not yet in an operational state. Documentation continues and EES has gathered a substantial amount of information on various computer systems. Metrics is gathering information on periphials for inclusion into an analysis hardware system.

II. PROBLEMS

We are having trouble with the overlay structure of the EES version and some modifications are being made.

III. WORK PLANNED FOR NEXT PERIOD

EES will continue its overlay attempts on IMGRID. Metrics & EES will try to compile all information on systems and decide what other information is needed.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$ 8,510
Materials & Supplies	1,200	4,162	(2,962)
Travel	300	427	(127)
TOTAL	$24,827	$19,406	$ 5,421

Monthly Progress Report No. 11

For the Period November 1, 1977 through November 30, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period a meeting was held with Bill Spann (Metrics) to discuss the material he had gathered on components of a digital analysis system. Also during this period the overlay structure of IMGRID was finalized. Testing of each module of the program will be performed in the coming months.

II. PROBLEMS

The overlay problem has been solved.

III. WORK PLANNED FOR NEXT PERIOD

During the next period the input/output subsystem of IMGRID will be tested and verified. Work will be done on trying to display data base elements in color on the Earth Resources Digital Analysis System (ERDAS).

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$ 8,510
Materials & Supplies	1,200	6,752	(5,552)
Travel	300	427	(127)
TOTAL	$24,827	$21,996	$ 2,831

Monthly Progress Report No. 12

For the Period December 1, 1977 through December 31, 1977

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397

(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

I. TECHNICAL PROGRESS SUMMARY

During this period the input/output subsystem of IMGRID was tested successfully. Maps of the test data base are now being put out on the EES printer/plotter. Further work was done on defining concepts for digital analysis systems.

II. PROBLEMS

No technical problems were encountered during this period.

III. WORK PLANNED FOR NEXT PERIOD

Next period EES intends to use the ERDAS color display for display of the data variables in color. The spatial search algorithm will be tested in this period since it is the algorithm which gives IMGRID its flexibility in spatial analysis. Work will continue on development of candidate digital systems and software documentation of EES computer programs.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$ 8,510
Materials & Supplies	1,200	7,431	(6,231)
Travel	300	427	(127)
TOTAL	$24,827	$22,675	$ 2,152

Monthly Progress Report No. 13

For the Period January 1, 1978 through January 31, 1978

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

May 1, 1978

I. TECHNICAL PROGRESS

Flow charting of NOVA analysis programs is nearing completion. The final report will include listings, verbal description, and flow charts of major earth resources and data base software. The IMGRID analysis system is now implemented on the NOVA and tests are being run to verify each module. Each program module has been implemented as an overlay on the NOVA to conserve space and allow reasonable array sizes for data elements. Several preliminary system concepts were developed during this period.

II. PROBLEMS

More time is being required for the costing analysis of the systems than expected. It is anticipated that a revised final report date will be requested.

III. WORK PLANNED FOR NEXT PERIOD

Flow charting of programs will be completed during the next period. Work is being started on optimizing and making conversational the IMGRID program. It is envisioned that a totally new program with a different file structure will result from this effort. Costing of the already developed system concepts will begin during the next period.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$8,510
Material & Supplies	1,200	6,423	(5,223)
Travel	300	427	(127)
TOTAL	$24,827	$21,667	$3,160

A1938

Monthly Progress Report No. 14

For the Period February 1, 1978 through February 28, 1978

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

May 1, 1978

I. TECHNICAL PROGRESS

During this period work was done on the development of new system concepts and the costing of these systems. Flow charting of the major earth resources programs is complete. A new version of IMGRID, NIMGRID is being developed at EES for geographic data base management. This program is a modification of IMGRID to provide for conversational entry, visual display on the ERDAS system, and a raster analysis capability which provides the ability of searching from a given condition in the data base on a line-by-line basis. Data files are stored, line at a time, in a random access mode. Thus, the size of a data base that may be treated is dependent only on disk space, not array size in the program.

II. PROBLEMS

More time is needed for the costing of potential analysis systems and the development of NIMGRID. A no cost extension is being requested until May, 1978.

III. WORK PLANNED FOR NEXT PERIOD

Some program listings will be generated to go into the report during the next period. New system concepts will be devised and evaluated on a cost and flexibility basis. Further work on NIMGRID will proceed next month.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$8,510
Materials & Supplies	1,200	7,197	(5,997)
Travel	300	427	(127)
TOTAL	$24,827	$22,441	$2,386

A-1738

Monthly Progress Report No. 15

For the Period March 1, 1978 through March 31, 1978

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

May 1, 1978

I. TECHNICAL PROGRESS

During this period the Georgia Department of Natural Resources (DNR) was involved in the testing of the minicomputer version of IMGRID and the design of NIMGRID. They are extremely interested in the versatility of both programs and the speed at which they operate on the NOVA. DNR is in the process of developing a hand coded geographic data base for North Fulton County, Georgia, an area just north of Atlanta. They wish to transfer the data to the ERDAS system and use the analysis and color graphics virtues of ERDAS in the furthering of geographic data base efforts in many state agencies. To this end, several presentations were made to state of Georgia groups at EES. Further work was done on NIMGRID in structuring the data file elements and testing of the analysis and file handling subroutines.

II. PROBLEMS

None

III. WORK PLANNED FOR NEXT PERIOD

During the next period a meeting with Sandford Downs - NASA/MSFC is planned to go over the structure of the final report. EES will transfer parts of the hand encoded North Fulton data base to the ERDAS system. Work will continue on the development of NIMGRID.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$8,510
Materials & Supplies	1,200	7,882	(6,682)
Travel	300	427	(127)
TOTAL	$24,827	$23,126	$1,701

Monthly Progress Report No. 16

For the Period April 1, 1978 through April 30, 1978

DIGITIZING OF LANDSAT DATA

by

N. L. Faust

Contract No. NAS8-32397
(A-1938)

Prepared for

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

by

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

May 22, 1978

I. TECHNICAL PROGRESS

During this period EES interacted daily with Georgia DNR in the transfer of the North Fulton data base to the ERDAS. The file structure of IMGRID would not allow a data base as large as the North Fulton area so a decision had to be made as to whether the data base would be broken up or NIMGRID used as the analysis tool. A joint decision was made to speed up the development of NIMGRID, and to use it for analysis of the North Fulton data base. Work is continuing on the final report, and several new systems were designed and evaluated. Five potential systems from very low to moderate cost ($25,000 - $160,000) are suggested and will be included in the final report.

II. PROBLEMS

None

III. WORK PLANNED FOR NEXT PERIOD

More of the data variables will be transferred from DNR to EES. Color graphic displays of data elements will be generated and NIMGRID analysis capability will be further tested. The final report draft and hopefully final copy will be produced during this period.

IV. BUDGET

	BUDGET	EXPENDED	FREE
Technical Effort	$23,327	$14,817	$8,510
Materials & Supplies	1,200	8,632	(7,432)
Travel	300	427	(127)
TOTAL	$24,827	$23,876	$ 951

FINAL REPORT

DESIGN OF A LOW COST EARTH RESOURCES SYSTEM

by

N. L. Faust
M. D. Furman
Engineering Experiment Station

and

G. W. Spann
Metrics, Inc.

Contract No. NAS8-32397
GT/Project No. A-1938

Prepared for

National Aeronautics & Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

August 31, 1978

FINAL REPORT

DESIGN OF A LOW COST EARTH RESOURCES SYSTEM

by

N. L. Faust
M. D. Furman
Engineering Experiment Station

and

G. W. Spann
Metrics, Inc.

Contract No. NAS8-32397
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Prepared for

National Aeronautics & Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Prepared by

Georgia Institute of Technology
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Atlanta, Georgia 30332

August 31, 1978

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I. INTRODUCTION

The Georgia Institute of Technology Engineering Experiment Station (EES) has been funded since 1973 by NASA Marshall Space Flight Center (MSFC) to assist the State of Georgia in utilizing Landsat digital analysis. In support of the Georgia state and local agencies and the usefulness of Landsat applications, the purpose of this project was to facilitate a transfer of technology, especially as related to low-cost Landsat data analysis systems. The major tasks accomplished during this project are discussed below.

The initial task involved a comprehensive survey of capabilities for digital processing of Landsat data in the Southern United States. Included was a review of the software and hardware currently being used by the southeastern states. Also, information was obtained on the commercial services used by those desiring to employ a Landsat data processing service.

As a second task, EES developed a set of minimum requirements (hardware and software) for a stand-alone Earth Resources Data Analysis System (ERDAS). The requirements developed in this phase represent a system that can be constructed at a minimum cost to the prospective user and can also satisfy the user's basic needs. The hardware for this system includes a minicomputer, line printer, disk drive, and tape drive while the software includes basic Landsat analysis techniques -- level slicing, maximum likelihood pattern recognition, clustering, and software scaling of the data. The primary products from such a system are computer printouts and statistics.

Since the user groups supporting an ERDAS system may vary greatly in size and available resources, a comprehensive plan was developed for expansion of the basic ERDAS system. This plan details a set of options, including approximate costs, and discusses the advantages of special equipment as well as the way that each equipment type complements the ERDAS concept.

One of the prime concerns in setting up an operational system is the hardware and software support needed to sustain a satisfactory operating schedule. Therefore, as the third task for this project, EES, through experience with its own ERDAS system, developed minimum requirements for continuing support for such a facility (software and hardware). A system such as ERDAS is versatile and is likely to be used for purposes other than earth resources analysis. It therefore will be in use most of the time and will necessarily require the availability of a skilled electrical technician. Software support may be obtained "in-house" or by contract. Some equipment manufacturers have extensive service contracts which prove cost effective.

As the fourth task of the project, EES has assembled a software library for the digital processing of Landsat and other multispectral scanner data using, whenever possible, existing techniques from NASA, the University System, and other public agencies. Software techniques for maximum likelihood classification, linear classification, clustering, level slicing, registration and rectification, and table look-up classification are available for implementation into an ERDAS system. Each module is designed on a user keyword structure so that no detailed knowledge of programming is needed. Documentation is available on programs written or changed exclusively at EES with references provided for other programs. Even though the basic software was developed on a Data General minicomputer at Georgia Tech, the software library was designed entirely in Fortran IV and the routines are transferable to other 16 bit minicomputers.

The final task of the project was the implementation of a limited version of the IMGRID Geographic Analysis program on the ERDAS system. By providing this system to state and local users, the wide range of applications for rectified Landsat data becomes far more evident than if the system were geared to produce only land cover maps. IMGRID produces a dynamic modeling tool for site planning, erosion control, environmental impact, and many other uses.

Report Organization

The remainder of this report discusses each of the five tasks in detail. Section II discusses the results of the comprehensive survey of capabilities for digital processing of Landsat data in the Southeastern United States. Section III presents various options for low cost earth resources processing systems and the minimum requirements for support of such facilities. Section IV discusses the IMGRID geographic analysis program. Appendix A contains descriptions of some of the major software available at EES, Appendix B contains a listing of the available Fortran software, and Appendix C presents flowcharts of some of the main analysis programs.

II. CAPABILITIES FOR AND USE OF DIGITAL LANDSAT DATA IN THE SOUTHEAST

Numerous individuals and/or organizations who are involved in the use of remote sensing data in the southeastern states were contacted in order to obtain information on their states' capabilities for digital processing of Landsat data. Included is a review of the software and hardware which are currently being used by these states as well as information on the commercial services used by those who wish to employ a Landsat data processing service.

The states involved are: Alabama, Georgia, Kentucky, Missouri, North Carolina, South Carolina and Tennessee. A brief summary of each state's capabilities also includes information on state funded projects utilizing Landsat data digitally processed by companies or organizations outside the state.

Alabama

NASA/Marshall Space Flight Center (MSFC) has the only current capabilities in Alabama for digital processing of Landsat data. Their hardware system consists of an IBM 360/75 with two megabytes of memory and several discs and tapes and a PDP11/45 with two 250-megabyte discs, three tape drives, and various displays and terminals. Approximately 375 computer software routines are available including all algorithms developed by any of the NASA centers. However, very little analysis of Landsat tapes is actually done with this system at present.

Georgia

In order to assist the State of Georgia agencies with their desire to incorporate digital Landsat data into their planning activities on an operational basis, the Georgia Tech Engineering Experiment Station (EES) approved the design and acquisition of the Earth Resources Data

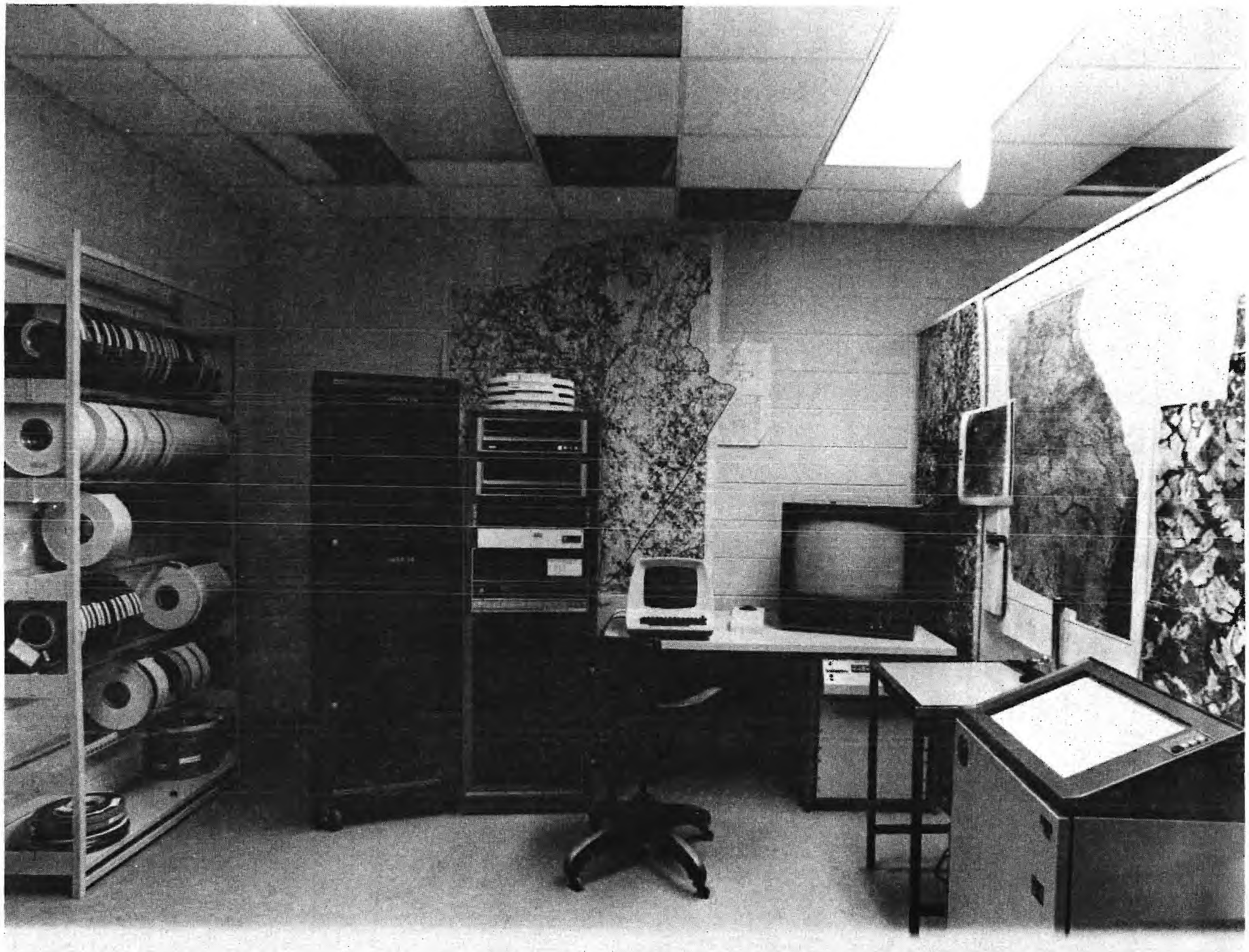

Figure 1. Georgia Tech ERDAS System

Analysis System (ERDAS). EES was responsible for selecting and integrating both the hardware and software components of the system.

Hardware. ERDAS was designed and constructed to allow true interactive digital processing of all types of remote sensing data. The system consists of a set of four modules: (1) minicomputer subsystem, (2) input medium, (3) hardcopy output medium, and (4) display subsystem.

The minicomputer subsystem consists of a NOVA-2/10 minicomputer with 64K bytes of core memory and a dual Diablo disk system with 5.0 megabytes of storage for programs or data.

The input medium for the ERDAS system is a set of two nine track dual density (phase encoded/NRZI selectable) magnetic tape drives and controller -- both drives with a capacity for 10-1/2 inch reel tape.

One hardcopy output device is a twenty inch electrostatic dot matrix printer/plotter. Scaled maps of Earth Resources data can be made using this device. A CROMALIN(R) photographic process may then be used to generate a color coded output hardcopy product. Another output method currently in use consists of storing images on a magnetic tape and sending these tapes to be made into images by the use of a digital film writer. This method is currently very inexpensive.

The display subsystem consists of a high quality color video image analysis system that is interfaced to the minicomputer for complete user interaction in the choice of training samples for earth resources classification.

Software. Initially, EES implemented a basic Landsat digital analysis program called ASTEP (Algorithm Simulation Test and Evaluation Program) which was obtained from NASA/JSC and has been extensively modified by EES personnel. The ASTEP system was designed as a modular program whereby various classification algorithms may be tested against one another using a standard input/output system.

Software for the rectification of Landsat data to map coordinates using a least squares fit of Landsat data to control points was obtained from NASA/MSFC and transferred to the Georgia Tech computer. Other software, such as various spatial clustering algorithms, was studied but has not yet been transferred. Software for a table lookup formulation for Landsat classification (ELLTAB) was obtained from NASA/ERL along with software for rectification, destriping, and polygon location of Landsat data. A fast combination table lookup and maximum likelihood classifier from NASA/ERL has been implemented which significantly decreases the length of time needed for a scene classification. A fast clustering algorithm from NASA/ERL has also been implemented. In addition, many software algorithms for image manipulation, spatial filtering, rectification, training field selection, and high speed classification have been developed at EES. EES software exists for image analysis on UNIVAC and CDC large computers and Data General minicomputers.

Projects. EES has been deeply involved in the formulation, planning, and implementation of a Georgia Natural Resources Inventory since its conception in 1972. During 1972 and 1973, EES presented various State of Georgia agencies with the background information needed to make an initial assessment of the usefulness of digital Landsat information. A trial project was initiated between the Georgia Department of Natural Resources (DNR) and EES in 1973 to test the capability for using digitally processed Landsat data to determine land use in the Atlanta area.

EES has been funded since 1973 by NASA/MSFC to assist the State of Georgia in utilizing Landsat digital analysis for various resource problems within the state. In this multi-year effort, several related tasks have been performed in conjunction with numerous local and state agencies within Georgia, including the Department of Natural Resources, the Department of Transportation (DOT), and the Office of Planning and Budget (OPB).

In 1975 Georgia Tech EES was designated as the technical interface with NASA/ERL for the transfer of NASA software to the State of Georgia. Under this technology transfer project EES purchased the necessary digital processing equipment required for operational processing of Landsat data. EES then coordinated a project with the Georgia DNR office of Planning and Research for classifying and mapping land cover for the State of Georgia. Products of the effort assured further acceptance of digital processing of Landsat data as an operational tool for environmental analysis.

Probably the best indicator of the success of the technology transfer efforts of this project is the number of agencies which have committed funds and/or personnel time to a project to map the entire State of Georgia using Landsat data. This project is concerned with mapping land cover using Landsat data processed with ERDAS and, where appropriate, inferring land use.

The agencies which have committed funds to the mapping project include:

Georgia Department of Natural Resources
- Environmental Protection Division
- Game and Fish Division
- Office of Planning and Research

Georgia Forestry Commission

Georgia Office of Planning and Budget
- Bureau of Community Affairs

U.S. Department of Agriculture
- Soil Conservation Service
- Forest Service

United States Army Corps of Engineers
- Fort Benning
- Savannah Engineer District

North Georgia Area Planning and Development Commission

Coosa Valley Area Planning and Development Commission

Other organizations which are interested but as yet have supplied no funds include:

Georgia Department of Natural Resources
- Earth and Water Division

Georgia Department of Transportation

Five other area planning and development commissions.

EES is currently assisting the Georgia DNR in a geographic data base demonstration project. DNR manually obtained 30 different data variables on a 10 acre cell basis for North Fulton County, Georgia. EES is assisting with transfer of the data to the ERDAS system and analysis of the data using IMGRID and NIMGRID.

In addition to the activities at Georgia Tech EES, the Atlanta Regional Commission (ARC) was involved in a project to test the feasibility of using automatic processing of Landsat data to detect land use changes in the seven county planning area of the ARC, and thereby update the USGS/LUDA land use map of the Atlanta Region.

The technique chosen to accomplish the land use change detection was the ratioing of two different dates of Landsat data. This was accomplished at the EROS Data Center utilizing the Image 100 System. The results of the project indicated that ratioing Landsat data was a feasible technique for ARC to use in updating the USGS land use maps of the area. Accuracy evaluations showed that 91% of the change theme was accurate to within about 3 pixels (accuracy sufficient for ARC's purposes). Additional manual analysis was required to identify accurately the types of land use changes.

Kentucky

Kentucky is currently developing the capability for in-house processing of Landsat digital tapes. A few state agencies and universities have small interactive graphics systems which are capable of digital processing, but these are being discarded in favor of a central state computer system. The central system includes an IBM 370/168 MP with 9 megabytes of main storage and various discs. The Bureau of Computer Services has been established as the central hardware agency. Their personnel have recently visited NASA/ERL to obtain compatible software for the system.

A representative from Eastern Kentucky University recently attended a workshop at GSFC on a joint Appalachian Regional Commission-NASA project to apply Landsat to the study of geological lineaments using GE's Image 100 System. An ORSA package was ordered from GSFC which provides an offline printout of similar pixels vs. significant changes, but this is not adequate for final classifications.

Five professors from Murray State University attended a short course at ERL and had plans to return the end of October for hands-on experience with digital tapes for strip mining studies in Western Kentucky.

Previous projects in Kentucky include a survey in 1973 by Earthsat of water impoundments larger than two acres. The results were not beneficial because the imagery was taken after a flood and strip mines appeared as impoundments. However, this led to a Landsat-2 follow-on study in 1976 for which ERIM provided the digital processing. The objective of the project was to look at the operations of inspection and enforcement to detect significant violations of surface mining laws.

Several projects have been contracted with Bendix Corporation for Area Development (AD) Districts in conjunction with EPA 208 land use planning programs. Color-coded maps and overlays were provided in 1976 for the Kentuckiana AD (seven Kentucky counties, two Indiana counties) at 1:48,000 scale. Area tabulations were also provided for each county. Processing for the Big Sandy AD (Prestonsburg, Kentucky) is in progress and maps are scheduled for delivery this fall. A contract has also been signed for the Green River AD (Owensboro, Kentucky) to be delivered in December, 1977. This project will provide information to meet HUD 701 requirements for land use planning.

Two counties of Kentucky were included in a digital processing project by Bendix for the Ohio-Kentucky-Indiana Council of Government (OKI COG). Color-coded maps at 1:62,500 scale and computer tabulations for each of 229 drainage basins were provided. Also, five counties centered around Fayette County (Lexington, Kentucky) known as the

Central Blue Grass Region (not an AD district) were mapped for the Army Corps of Engineers.

The LARS program at Purdue was used to produce a land cover map of Henderson County in Western Kentucky (part of Southeastern Indiana COG).

Missouri

According to the final report of a project on Earth Observation Data Mangement Systems in December, 1976, "few agencies (in the five state Midwestern region of Illinois, Iowa, Minnesota, Missouri, and Wisconsin) now have the staff or computer capabilities to handle digital satellite data."[1] At the present time, Missouri still has no capabilities for digital processing of Landsat data. However, the University of Missouri at Rolla recently received a grant from the National Science Foundation and has ordered a Comtal Interactive Image Analysis System which will be used for such processing. Delivery occurred in early 1978. Software will be obtained from NASA/ERL.

Several Missouri agencies have funded projects for digital processing in the past. A demonstration study of land use in the Ozarks Planning Region of Southern Missouri was conducted by NASA/ERL in 1975.[2] The Soil Conservation Service in Missouri has digital tapes processed by LARS/Purdue for water analysis and study of soil patterns. Also, the Missouri Geological Survey had the University of Kansas in Lawrence process some digital tapes for an area around Kansas City, Missouri.

North Carolina

Currently North Carolina has no facilities for processing digital Landsat data although considerable interest exists for establishing a centralized state system. Several projects have been completed by Bendix Corporation for EPA 208 planning regions in North Carolina. Color-coded land use overlays at 1:96,000 scale were produced using the Multispectral Data Analysis System (M-DAS) at Bendix in 1975 for

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[1] Eastwood, et al., "Project on Earth Observation Data Management Systems," Final Report, Washington University, St. Louis, Missouri. Prepared for GSFC, December 31, 1976.

[2] "A Computer Implemented Land Use Classification Technique Applied With ERTS Digital Data Acquired Over Southern Missouri," Report number 143, April 1975, ERL/JSV, A. T. Joyce and J. D. Derbonne'.

Planning Region J (also known as Triangle J -- five counties in central North Carolina -- Raleigh, Durham, Chapel Hill areas). An additional product of the analysis process was the generation of statistical data by 50x50 meter grid cells in data sets corresponding to 54 7-1/2 minute USGS quadrangle maps. Overall classification accuracy of the land use categories was judged to be around 90% and the cost of processing the Landsat scene and generating the products was approximately $4.00 per square mile.

A similar analysis was done in 1976 by Bendix for Planning Region D in the Northwestern part of the state. Also, analysis of the Dan River Sub-Basin (Roanoke River Basin) was completed this year for the Corps of Engineers. NASA had some involvement in the most recent project.

South Carolina

South Carolina has no capabilities at present for digital processing of Landsat data. A proposal has been submitted to NASA/ERL for projects which may involve digital processing. Previous activities include a contract with General Electric Company for Image 100 processing of Landsat data to produce color-coded land use maps and area calculations for three Council of Government (COG) regions comprising approximately 25% of the state. Landsat tapes were processed by NASA to produce a map of the Congaree Swamp area for the Wildlife and Marine Resources Department. The Land Reserve Conservation Commission and the Bureau of Mines visited the EROS Data Center for processing of digital tapes for a study of mining areas in South Carolina.

Tennessee

The only current capabilities in Tennessee for digital processing of Landsat tapes are at the University of Tennessee, Knoxville. The facilities are presently being used for image processing projects other than earth resources, although previously they have been used for Landsat analysis. Oak Ridge National Laboratory has accomplished strip mining surveys using some Landsat data.

Bendix Corporation completed a digital processing project on water resources and strip mining in the New River Drainage Basin in North-central Tennessee for the Soil Conservation Service in early 1976. They provided a color-coded map of the Basin at 1:62,500 scale, fifteen color-coded 7-1/2 minute quads, computer tabulations, and rescanned-resampled tapes for the area.

Summary

Of all the Southeastern states, Georgia is the most advanced in the use of digital Landsat data. The University of Tennessee at Knoxville has the capability for digital processing of Landsat data but no such projects are currently underway. All other states have relied on NASA or commercial facilities. The most extensive use of digital Landsat data among these states has been in fulfillment of EPA 208 and HUD 701 planning requirements.

The results of this survey indicate that users of remote sensing data in the Southeastern U.S. are increasingly turning to digital processing techniques. All the states surveyed have had some involvement in projects using digitally processed data. Even those states which do not yet have in-house capabilities for digital processing are extremely interested in and are planning to develop such capabilities.

III. DESIGN OF LOW COST EARTH RESOURCES DATA PROCESSING SYSTEMS

In the design of an earth resources data processing system there are many factors to be considered. In some cases potential users should buy turn-key systems that are currently on the market; in other cases, users might consider the design and implementation of their own systems by buying components and assembling the systems using their own technical expertise. This section deals with alternative systems that might be considered by users having the technical expertise for assembly of such a system within their agencies or support groups.

With the appropriate technical personnel available, a significant cost savings often may be realized by user design and implementation of systems. At least one part- or full-time computer hardware technician, one applications software analyst, and several applications programmers are desirable for all phases of system design. These requirements may be lessened, however, if sufficient support is available from the various equipment manufacturers.

Computer software for digital processing of earth resources and other geographically based data is currently becoming available for minicomputers at minimal or no cost. Since a significant amount of this computer software has been developed under government contracts, it is in the public domain and readily available. Thus the costs involved in the acquisition of the systems listed here are primarily the actual hardware costs. If they are needed, personnel training costs and systems interface costs are extra.

Figure 2 indicates five alternative configurations for low cost earth resources data processing systems. At the low end is a nominal system consisting of a minicomputer, floppy disk, magnetic tape unit, color terminal, and line printer. The estimated cost range for this system (depending on the exact components selected) is $22,000 to $45,000.

At the upper end of the range (still, however, at a price significantly less than many systems on the market) are systems costing an estimated $165,000 to $220,000. This configuration, with substantially increased capability over the lower cost system, consists of a minicomputer with an array processor, a 96 megabyte disk, dual magnetic tape drives, a digitizer, a color display, a line printer, and a film recorder.

In general, as the systems increase in cost, the processing sophistication is improved and the speed with which a data set can be analyzed increases rapidly. Thus, for users requiring only a low volume of processed data, a system in the low or middle cost range might be suitable. For users desiring a faster processing speed and an increased through put, a more expensive system might be in order.

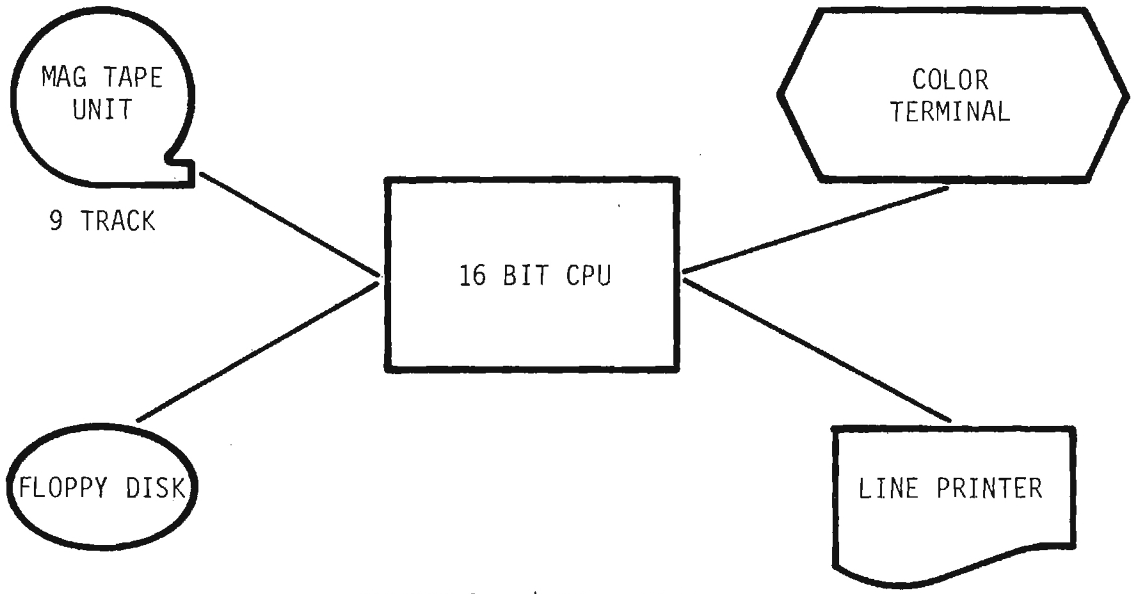
The breakdown of the total costs for each system is shown in Table I. For each system, the high and the low cost estimate for each component is given. Thus, by selecting particular components with a greater or lesser capability, systems could be configured that cost anywhere within the range of the cost extremes given.

To facilitate the estimation of costs for system configurations other than those listed in Figure 2, the costs of the individual components are given in Table II. Using these data, the approximate costs of many more low cost system configurations could be derived. Typical vendors of such components are given in Table III.

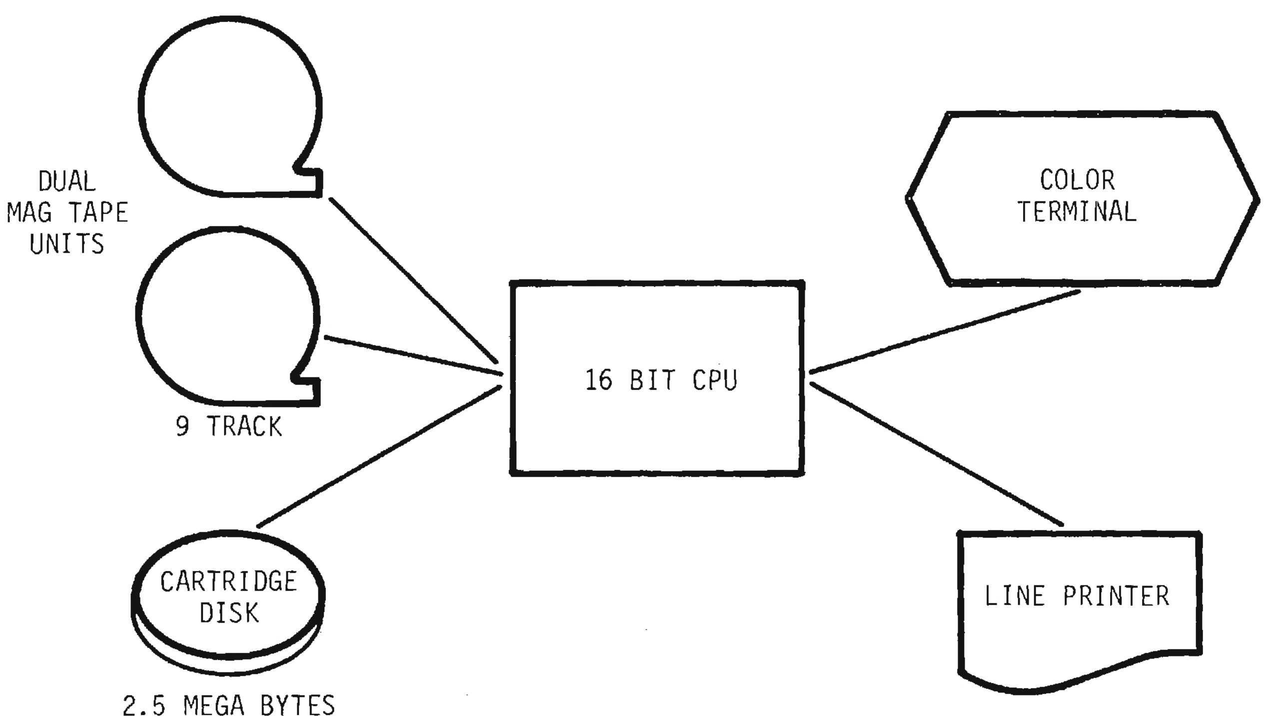
Estimated Cost for ERDAS Support

A minimum cost estimate for the support of the Georgia Tech ERDAS system over a one year period totaled $2,500. This estimate includes approximately 400 hours of a resident part-time technician along with all electrostatic line printer supplies and any additional maintenance charges incurred when repairs exceeded in-house capabilities.

This estimate is approximately 3.3% of the total cost of the ERDAS system. As maintenance contracts usually run about 10% of system costs per year, a significant savings was realized using in-house methods of maintaining the equipment.

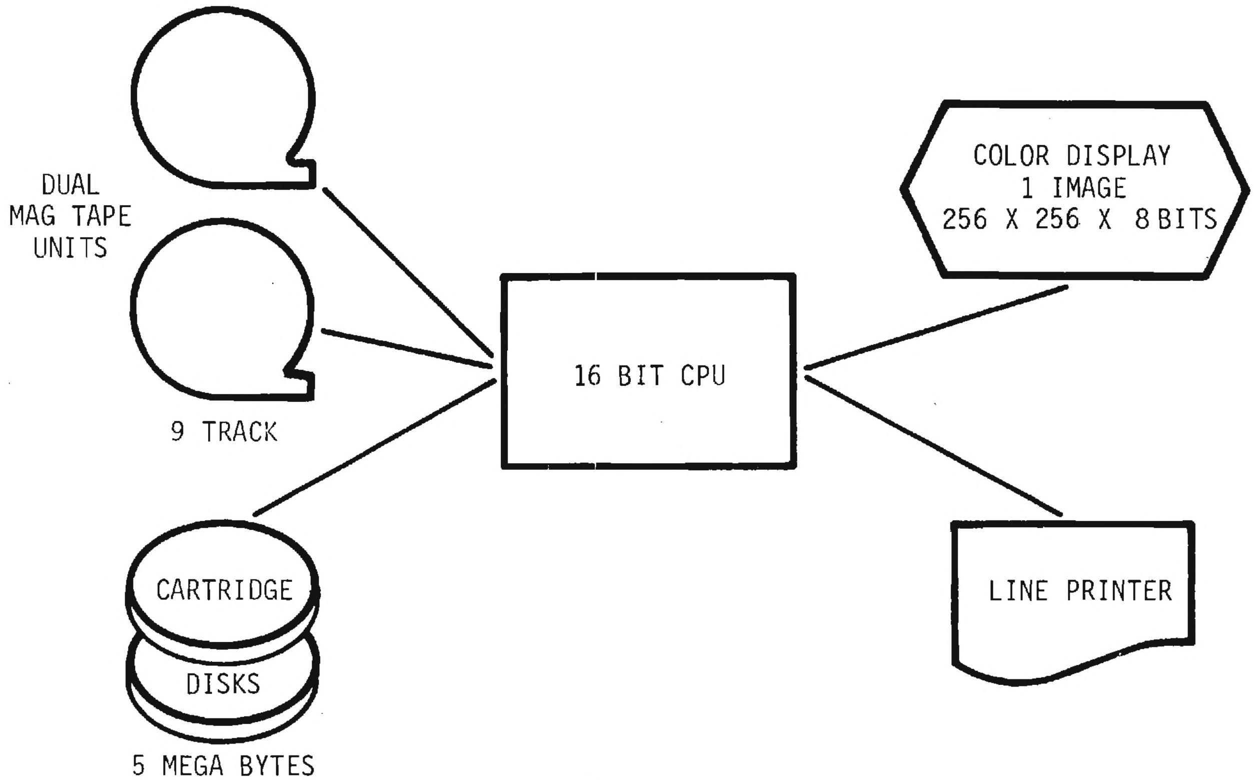


SYSTEM A: $ 22 - 45 K

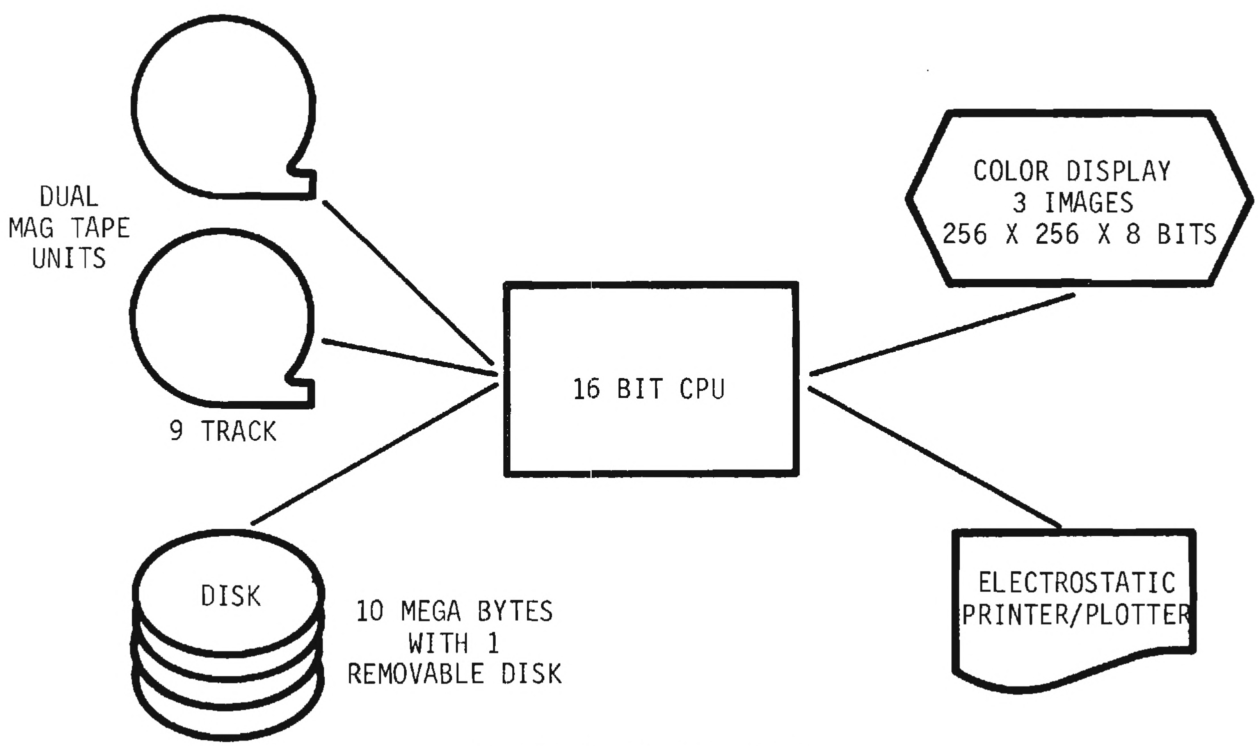


SYSTEM B: $34 - 54 K

Figure 2

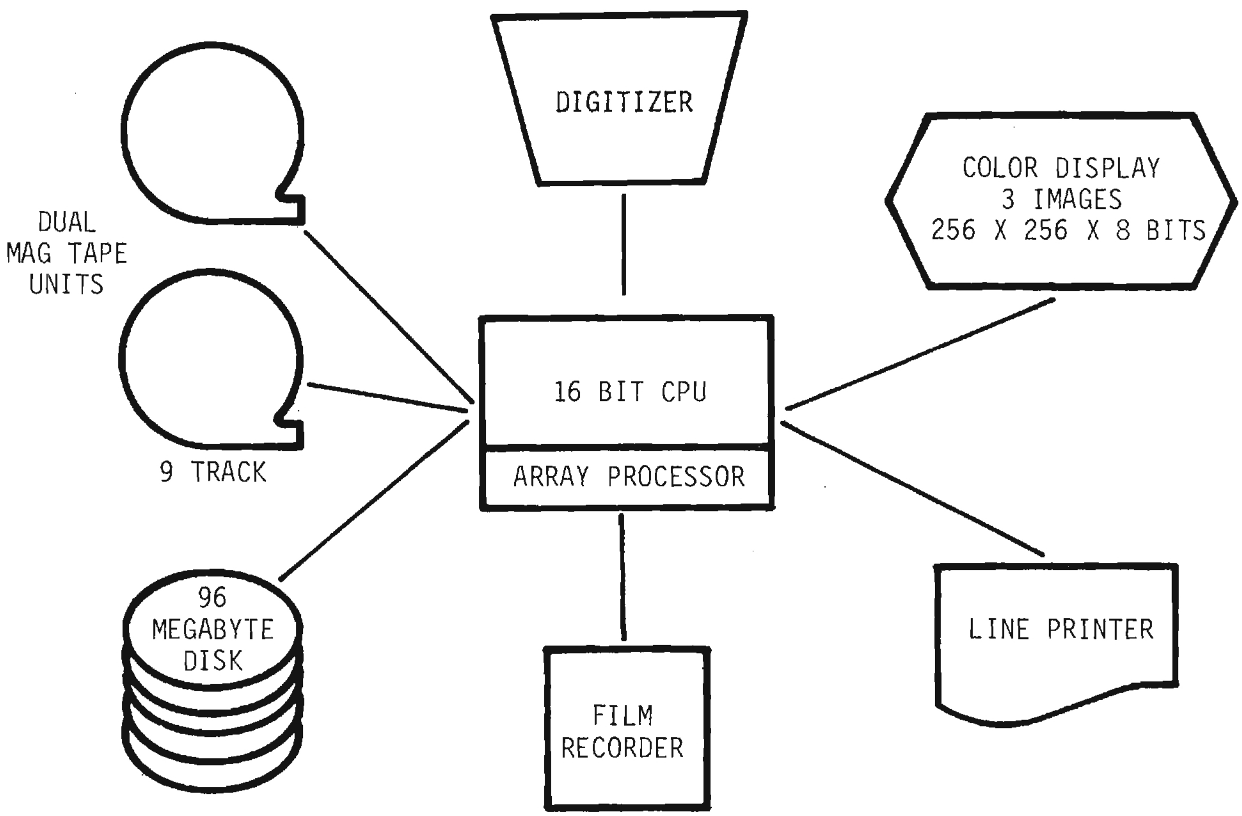


SYSTEM C: $ 53 - 74 K



SYSTEM D: $ 69 - 98 K

Figure 2 (Continued)



SYSTEM E: $165 - 220 K

Figure 2 (Continued)

TABLE I. INDIVIDUAL SYSTEM COMPONENT COST ESTIMATE

		LOW - HIGH
SYSTEM A:	TAPE DRIVE	$ 5 - 10 K
	CPU	$ 8 - 18 K
	DISK	$ 2 - 4 K
	LINE PRINTER	$ 5 - 8 K
	COLOR TERMINAL	$ 2 - 5 K
		$ 22 - 45 K
SYSTEM B:	TAPE DRIVE	$ 12 - 14 K
	CPU	$ 8 - 18 K
	DISK	$ 7 - 9 K
	LINE PRINTER	$ 5 - 8 K
	COLOR TERMINAL	$ 2 - 5 K
		$ 34 - 54 K
SYSTEM C:	TAPE DRIVE	$ 12 - 14 K
	CPU	$ 8 - 18 K
	DISK	$ 9 - 11 K
	LINE PRINTER	$ 5 - 8 K
	COLOR DISPLAY (256 X 256)	$ 19 - 23 K
		$ 53 - 74 K
SYSTEM D:	TAPE DRIVE	$ 12 - 14 K
	CPU	$ 8 - 18 K
	DISK	$ 9 - 11 K
	ELECTROSTATIC PRINTER/PLOTTER	$ 10 - 20 K
	COLOR DISPLAY (3 images 256 X 256)	$ 30 - 35 K
		$ 69 - 98 K
SYSTEM E:	TAPE DRIVE	$ 12 - 14 K
	CPU	$ 8 - 18 K
	DISK	$ 20 - 35 K
	FILM WRITER	$ 40 - 50 K
	ARRAY PROCESSOR	$ 40 - 45 K
	LINE PRINTER	$ 5 - 8 K
	DIGITIZER	$ 5 - 15 K
	COLOR DISPLAY (3 images 256 X 256)	$ 30 - 35 K
		$165 - 220 K

TABLE II. INDIVIDUAL COMPONENT COST ESTIMATE

1)	1 Mag Tape Drive & Controller	$ 5 - 10 K
2)	2 Mag Tape Drives & Controller	12 - 14 K
3)	16 Bit CPU with 32 K Memory	8 - 18 K
4)	Line Printer	5 - 8 K
5)	Floppy Disk	2 - 4 K
6)	Dual 2.5 Megabyte Drive & Controller	9 - 11 K
7)	10.0 Megabyte Cartridge Disk	9 - 11 K
8)	Electrostatic Printer/Plotter	10 - 20 K
9)	Array Processor	40 - 45 K
10)	96 Megabyte Disk	25 - 35 K
11)	Color Terminal	2 - 5 K
12)	Color Display Image 256 x 256	19 - 23 K
13)	Color Display 3 Image 256 x 256	28 - 35 K
14)	Film Writer	40 - 50 K

TABLE III. TYPICAL VENDORS

COMPUTERS

- Data General Corporation
- Digital Equipment Corporation
- Hewlett Packard Corporation

MAGNETIC TAPE DRIVES

- Digi-Data Corporation
- Pertec Computer Corporation
- Kennedy, C. J. Company

DISKS

- Control Data Corporation
- Data General Corporation
- Digital Equipment Corporation

COLOR DISPLAY SYSTEMS

- Aydin Corporation
- Comtal Systems Corporation
- ITT Grinnell Corporation
- Ramtek

ELECTROSTATIC PRINTERS/PLOTTERS

- Versatec Incorporated
- Varian Data Machines
- Gould Incorporated

DIGITAL FILM RECORDERS

- Dicomed Corporation
- Optronics International Incorporated

DIGITIZERS

- Summagraphics
- Bendix Corporation
- Talos System Incorporated
- Aristo Graphics Corporation

LINE PRINTERS

- General Electric Company
- Okidata Corporation
- IBM
- Varian Data Machines

IV. THE IMGRID GEOGRAPHIC ANALYSIS PROGRAM

IMGRID, an information manipulation system for grid cell data structures, is a package of computer programs designed for the analysis of natural resource and land planning data which is qualitative in its thematic content and varies over geographic space. Originally developed by David Sinton of the Harvard University Department of Landscape Architecture, the IMGRID system has been adapted for use on mini-computers at Georgia Tech.

The IMGRID system has been designed for people having no previous experience with computers. The basic operations are controlled with simple keyword commands which may be used with a basic knowledge of planning principles but without any knowledge of programming. Thus, a link is provided for easy access and manipulation of digital data bases. Some typical project applications of the IMGRID system are:

- River basin planning
- Siting of facilities such as airports or sanitary landfills
- Environmental impact statement review
- Visual Analysis
- Project review by regional planning agencies

KEYWORD STRUCTURE

The basic structure for an IMGRID keyword command involves three processes:

1. Retrieve one or more data elements from the data file.
2. Transform or manipulate the values for each grid cell in the data elements retrieved.
3. Store the new data element created in the data file.

On the Georgia Tech ERDAS, keyword commands are entered on a CRT terminal, executed by the NOVA II mini-computer, and output either in color on the Comtal video display, or in black & white on a dot matrix printer. The data files are usually stored on tape then read into a disk file. The IMGRID program itself also resides on a disk.

The keyword commands fall basically into 9 groups:

1.) Data Entry & Management

Two keywords can be used to enter new information into the data base:

- STORE - operates on an element (data variable) by basis. When a new variable, such as a soil type or slope category is added to the data base for all cells, STORE can be used.
- UPDATE - operates on a cell by cell basis. If a single cell changes characteristics for a particular variable, such as a land use change from agricultural to residential, UPDATE is used along with the row and column location, plus the new value of the cell.

Three keywords which are used for data management are:

- RELOC - permits a data element to be moved to a new location within the data file, such as relocating the results of an analysis as a new data element in another location.
- RENAME - allows the name of a data element to be changed without affecting the contents of the data.
- LIST - allows a user to list the names associated with the contents of part or all of the data base.

2.) Delimiter Keywords

- MODEL - used as a first keyword in a sequence of keywords defining an analysis. The primary function of MODEL is to assign a title to subsequent analyses. It also includes the function of the CLEAR keyword.
- CLEAR - clears the results of operations performed by previous keywords.
- END - identifies the completion of IMGRID input.

3.) Display Keywords

- SYMBOL - allows a user to enter a specific set of character symbols to be used when making a map display.
- MAP - makes a graphic display of the contents of a data element in the file. This can be a data variable such as a MAP of a slope, or of the results of an analysis such as vulnerability to soil erosion.
- TEXT - premits user to insert textural descriptions of the procedures being undertaken.

4.) Spatial Analyses

- SEARCH - generates a set of values which identify the proximity of each cell in the study area to a specified condition, such as roads, rivers, or airports. The analysis determines how far every other location is from the preselected data items.
- ASEARCH - operates on a cell by cell basis examining for a prespecified radius, the conditions around every cell, or a defined subset of cells in the study area, such as how many cells of wetlands are there within a five cell radius of a landfill.

5.) Rescaling or Restructuring of Data Values

- RECODE - assigns new values to an old set of values for a data element, such as recoding an old set of values for element "land market value" to reflect land use or tax policy changes. Recode assigns values in the range of 0-9.
- XRECODE - an extended recode which assigns values in the range of 0-19. The RECODE keywords assign the last value specified in the case where multiple elements are being combined with different value scales.

- OVERLAY - assigns the highest value, rather than the last value, when multiple elements are being combined. The system will over-ride the values assigned on the first element if the new values generated by the rescaling are greater than the previously existing values.

6.) Logical Combinations of Elements

- MATRIX - results in a series of values which identify each of the possible combinations of features, such as the highly erodible soils on steep slopes.

7.) Reject Conditions

- REJECT - permits the user to identify a group of cells which must be ignored ("dropped out") in all analysis and display of the data, such as rejecting unstable soils in an analysis for siting a large industrial complex.

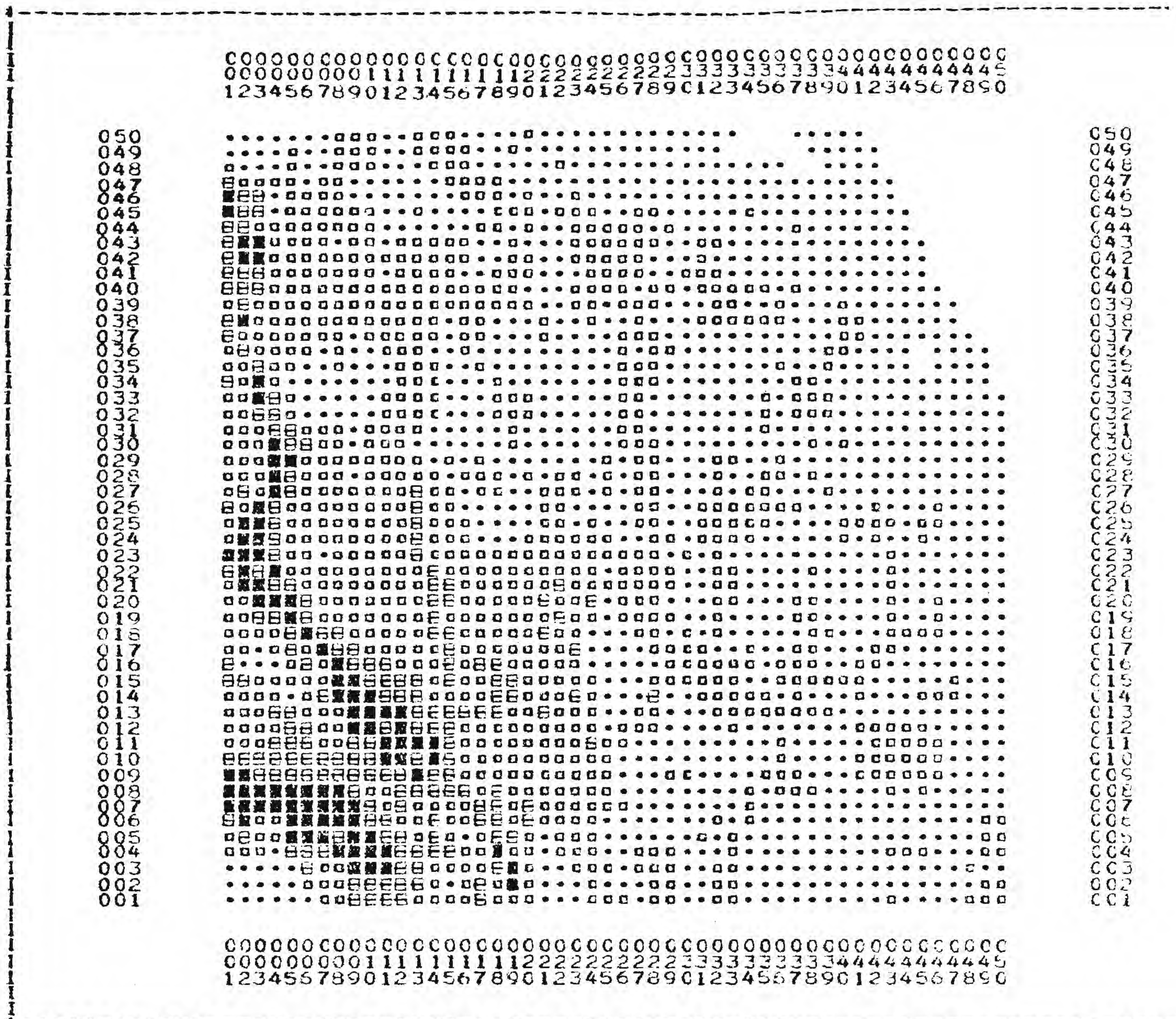
8.) Mathematical Manipulation of the Data

- MULTPLY - allows user to multiply the values in one data element by the values in a second data element.
- INDEX - generates a weighted index of several data elements and also provides for addition and subtraction.
- NORMAL - takes data values over large ranges and normalizes them to the range of 0-99.
- REDUCE - generates values in the range of 0-19.

9.) User Written Fortran Subroutines

- USERSUB - allows user to write a Fortran subroutine to perform any set of computations that is desired and call that subroutine through the USERSUB keyword.

Figure 3 shows an example of IMGRID output where elements of slope, depth to water table, soils, vegetation, proximity to roads, and travel time were weighted, overlaid, recoded and mapped to produce an attractiveness model for industrial parks. The darkest cells are best for industrial sites using the criteria specified.



LEVELS	0	1	2	3	4
FREQUENCY	93	1157	968	189	93

KEY:
0 = LT. 0.00
1 = 0.00 - 50.00
2 = 50.00 - 80.00
3 = 80.00 - 95.00
4 = GT. 95.00

VARIABLE #	VARIABLE NAME	WEIGHT
3	SLOPE	2.00
4	DEPTH TO SEASONAL HIGH WATER TABLE	2.00
6	SOILS	1.00
15	FOREST TYPE	1.00
23	SEARCH FOR HEAVY DUTY ROADS	2.00
30	TRAVEL TIME FROM RT. 139	3.00

ATTRACTIVENESS FOR INDUSTRIAL PARKS - HIGH VALUES EXPANDED - RECODED

Figure 3

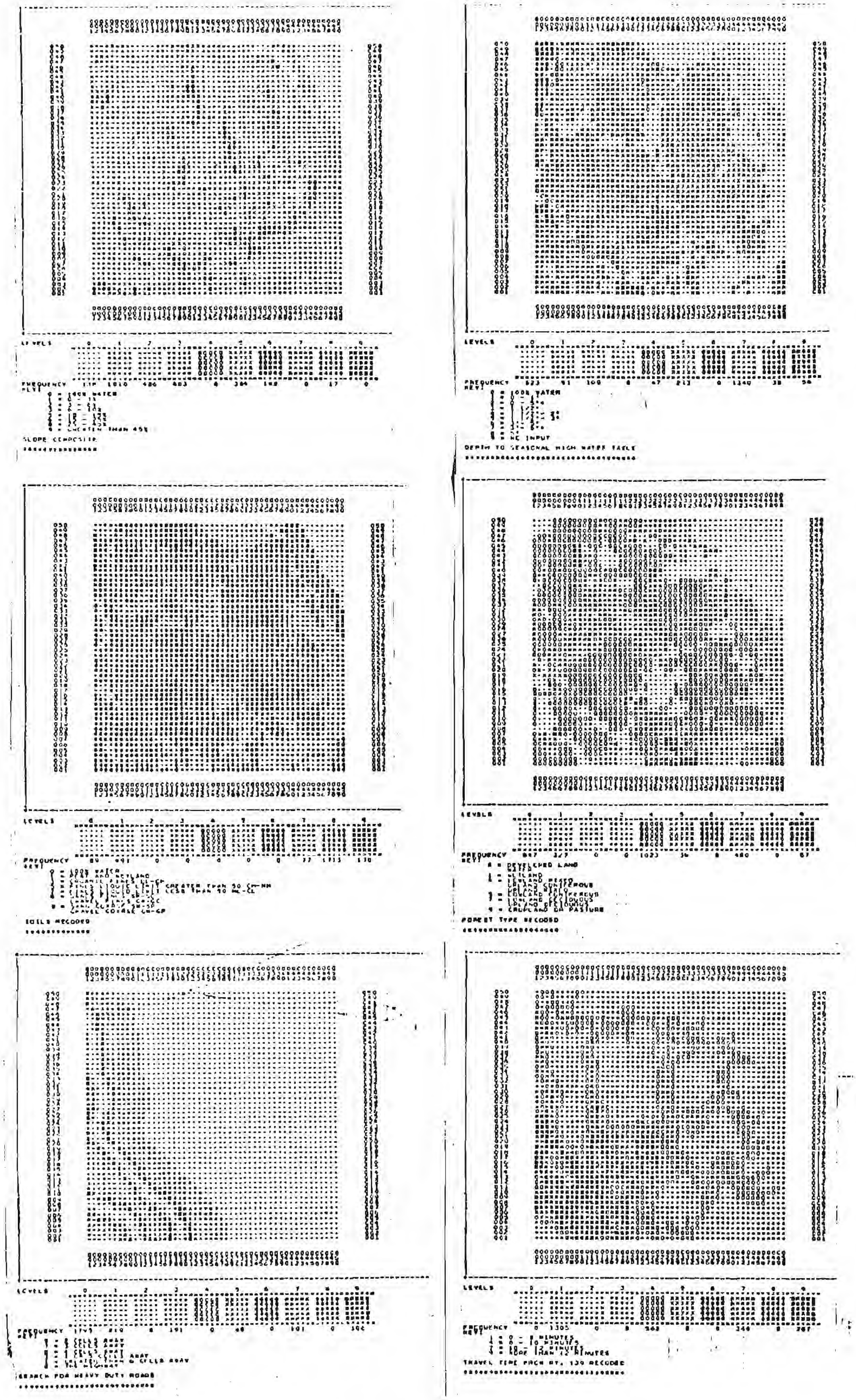


Figure 3 (Continued)

Because of the large size of IMGRID and the limited address space of a 16 bit computer, a method was devised to partition the IMGRID program into independent subroutines. Each subroutine corresponds to a keyword in the above discussion. By making each major subroutine an overlay, IMGRID was implemented on the NOVA 2 minicomputer. A core part of the IMGRID program resides in the computer at all times, and when a particular keyword is selected, only programs that provide that function are loaded into the main memory of the minicomputer from disk storage. While some delay occurs in the program execution due to the overlay procedure, the time required is negligible compared to the execution time of the analysis modules.

The structure of the minicomputer IMGRID program allows two data variables in a format of up to sixty elements by sixty elements to be analyzed at one time. In the Atlanta, Georgia area, this array size is sufficient to represent data for a USGS seven and one half minute quadrangle in approximately ten acre elements. For a large area, therefore, data for a data set of the whole area would have to be partitioned into segments dependent on the selected cell size.

All keyword functions with the exception of the search algorithms could easily be performed on such a segmented data set. Any application for which a search from some criterium is specified, however, would encounter problems when needing to search beyond the boundaries of one data segment. In addition, the normal mode of operation for IMGRID is execution in a batch runstream in which a set of input data is required in special formats. While this method is sometimes desirable when using cards as input to a large computer, an alternate interaction method should be considered when dealing with minicomputers where the user has direct contact with the computer itself and he may often be the only user using the system at one time.

In an effort to alleviate some of the difficulties given above a new minicomputer version of IMGRID, called NIMGRID, has been developed at EES. NIMGRID reflects to a large extent the program philosophy of the original IMGRID program regarding types of functions performed on the data base, but a new philosophy of data storage and retrieval and program interaction was implemented in early 1978. The data storage philosophy envisions each data variable as being represented by a raster data set which is only constrained by the disk space available to the user of a particular system. The data are processed on a line by line basis, and even for the search algorithm, only two lines of the data set are needed in the computer at one time. While this method involves many more input/output operations than the IMGRID method, very little degradation in preformance has been noted in comparing NIMGRID and IMGRID.

The prime advantage of this storage and retrieval philosophy is that the size of the data set that may be processed by a user is virtually unlimited. Also, searches may be made over large areas without problems associated with crossing data segment boundaries. Another virtue of the NIMGRID system is that the program has been made interactive. Prompting of the user occurs, giving him all possible choices and asking him to select the desired command. No knowledge of FORTRAN and very little knowledge about the particular minicomputer is required of the user. Although NIMGRID is still under development, applications personnel from the Georgia Department of Natural Resources are currently using the program at EES with ease.

APPENDIX A

DESCRIPTION OF MAJOR SOFTWARE RELATED TO IMAGE PROCESSING AND EARTH RESOURCES AT EES

PROGRAM NAME: RECRAW

LANGUAGE FORTRAN IV

COMPUTER SEL 32/55, CDC Cyber 74

SPECIAL PERIPHERALS: 2 Tape Drives
Disk Files

PURPOSE: RECRAW uses a first order transformation matrix from COORD to resample raw Landsat data by a selectable nearest neighbor or bilinear interpolation to format the data into a standard coordinate system.

PROGRAM NAME: RECCL

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2, CDC Cyber 74, SEL 32/55

SPECIAL PERIPHERALS: 2 Tape Drives
Disk Files

PURPOSE: RECCL uses a first order transformation matrix computed by COORD to resample Landsat classified data using nearest neighbor and format the data into a Latitude-Longitude or UTM coordinate system.

PROGRAM NAME: 3DPLOT

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2,CDC Cyber 74

SPECIAL PERIPHERALS: Calcomp plotter or printer/plotter
Disk Files

PURPOSE: 3DPLOT provides a perspective view of three dimensional data (z = f(x,y)). Viewing angle and scaling may be specified by the user. This technique is especially useful in analysis of topographic related data.

PROGRAM NAME: MAX18 (NASA/ERL)

LANGUAGE: FORTRAN IV

COMPUTER: SEL 32/55, CDC Cyber 74

SPECIAL PERIPHERALS: Two Tape Drives
Disk Files

PURPOSE: MAX18 was developed by Ronnie Pearson of NASA/ERL (Slidell, Louisiana) as a fast classifier of Landsat MSS data. The program is a combined table look-up-maximum likelihood type of classifier which uses the best points of each technique. Instead of creating a look-up table defining the boundaries of statistical distribution of signatures, this technique iterates quickly through the data building a table of where in channel space the majority of the data in a Landsat scene lie. Then, these vectors are classified using a maximum likelihood scheme. A second iteration is made through the data for classification. Each pixel of MSS data is checked to see if the data vector associated with that pixel is in the already classified data table. If so, the classification is derived by simply indexing into the classified table. If the data vector has not already been classified a maximum likelihood decision rule is used. There is a distinct trade off between amount of storage and speed of classification. On the SEL machine a Landsat scene may be classified into 60 classes in 1.5 - 2 hours.

PROGRAM NAME: 2DFFT

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2, CDC Cyber 74

SPECIAL PERIPHERALS: Magnetic Tape Drives
Disk Files

PURPOSE: 2DFFT performs a two dimensional Fast Fourier Transform on image data. Options in the program include:

a) Forward transform

b) Inverse transform

c) Image filtering by specification of one of many optional filters.

PROGRAM NAME: FILTER

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2

SPECIAL PERIPHERALS: Image display system and 1 tape drive or 2 magnetic tape drives

PURPOSE: FILTER is a program whose concept was taken from a technique used at USGS, Flagstaff, Az. for high frequency enhancement of image data. The basic method involves taking a windowing approach to create a low pass filtered image and subtracting that image from the original image. The resultant is essentially a high pass filtered image. By adding the high pass filtered image to the original image the high frequency enhancement is achieved.

PROGRAM NAME: IMGRID (Harvard U.)

LANGUAGE: FORTRAN IV

COMPUTER: CDC Cyber 74, NOVA 2 (Data General)

SPECIAL PERIPHERALS: Disk Files

PURPOSE: IMGRID is a general purpose geographic data base manipulation program developed by the Harvard University Graduate School of Landscape Design. This program provides for manipulation of multiple data variables related to the same geographic area and in a gridded format. Spatial searching, statistics generation, and modeling via multivariable weighting parameters are key to its analysis capability. Visual and environmental impact analysis are two uses of such a system.

PROGRAM NAME: TOPO

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2

SPECIAL PERIPHERALS: Tape Drive
Image Display

PURPOSE: After breaking down the NCIC topographic tapes into NOVA 4096 record blocks with the CDC Cyber 74, TOPO unpacks and displays the data on the imaging system. Various scales may be represented by selection of parameters in the program.

PROGRAM NAME: SCORECARD

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2

SPECIAL PERIPHERALS: Tape Drive

PURPOSE: SCORECARD performs a maximum likelihood classification on specific polygons within a data set. This is used to evaluate accuracy of classification by comparing the classified data for test fields to known ground truth.

PROGRAM NAME: THERMAL

LANGUAGE: FORTRAN

COMPUTER: Data General NOVA 2

SPECIAL PERIPHERALS: Tape Drive
Image Display

PURPOSE: THERMAL is a program designed to unpack and display digital thermal data from a NASA owned thermal scanner - RS18.

PROGRAM NAME: CHAN24

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA 2

SPECIAL PERIPHERALS: Image Display
Tape Drives

PURPOSE: CHAN24 unpacks data from the Bendix 24 channel aircraft scanner and reformats the data such that single channels may be accessed and written out to either tape or an image display.

PROGRAM NAME: M60CL

LANGUAGE: FORTRAN IV

COMPUTER(S): Data General NOVA 2

SPECIAL PERIPHERALS: 2 Tape Drives
Disk

PURPOSE: M60CL uses a maximum likelihood decision rule to classify Landsat data into one of up to sixty classes for which means and covariances are available on a disk file. Thresholds (probability of correct classification) are output for each record of data. This program is a record by record classifier. One record is read from tape, classified, and then written to an output tape before the next record is processed.

PROGRAM NAME: ASTEP

LANGUAGE: FORTRAN IV

COMPUTER: CDC Cyber 74, UNIVAC 1108

SPECIAL PERIPHERALS: Tape Drives
Disk Files

PURPOSE: ASTEP is a general purpose earth resources analysis program developed by TRW Systems for NASA Johnson Space Center. The acronym ASTEP stands for Algorithm Simulation Test and Evaluation Program. The program is of modular construction with standardized input-output such that they are essentially transparent to the user. Different classification, clustering, statistics generating, or feature selection algorithms may be tested against one another with a minimum of programming change to the whole system. In addition to its usefulness as an algorithm test bed, ASTEP has been used effectively as an operational, interactive classification system for Landsat data.

PROGRAM NAME: SEARCH (NASA/ERL - Ronnie Pearson)

LANGUAGE: FORTRAN IV

COMPUTER: SEL 32/55

SPECICAL PERIPHERALS: 1 Tape Drive
Disk Files

PURPOSE/DESCRIPTION: SEARCH is a program developed by Ronnie Pearson of NASA/ERL for unsupervised development of signatures for use in a maximum likelihood classification scheme. A 3 x 3 or 6 x 6 pixel moving window is used in a single iteration through the raw Landsat data to form candidate signatures. A maximum number of acceptable signatures is specified and a divergence criterion is used for merging, splitting, and selection of signatures. This program normally takes approximately one hour for development of signatures for one Landsat scene. Auxiliary programs are available for intuitively assigning color values for each class for use on a color display based on a two dimensional plot of the signature means for channels 2 and 4 of Landsat MSS data.

PROGRAM NAME: COORD

LANGUAGE: FORTRAN IV

COMPUTER(S): CDC Cyber 74

SPECIAL PERIPHERALS: Disk Files

PURPOSE: COORD accepts pairs of Latitude-Longitude or UTM coordinates and Landsat pixel coordinates for Ground Cortrol Points(GCP) and computes a least squares fit of the transformation matrix needed to map Landsat data into a standard coordinate system.

PROGRAM NAME: CLUSTER

LANGUAGE: FORTRAN IV

COMPUTER(S): Data General NOVA 2, CDC Cyber 74

SPECIAL PERIPHERALS: 2 Tape Drives

PURPOSE: CLUSTER is a sequential clustering algorithm which creates an unsupervised classification of Landsat or aircraft multispectral scanner (MSS) data using a Euclidean distance measure as a decision criterion. This system decides how many "different" types of land cover there are in a MSS scene. This system is dependent on user input parameters which specify the criteria for number of clusters, merging, creation of new clusters, and exclusion of clusters. This technique is often used to define training fields for supervised classification.

PROGRAM NAME: CLUST (NASA/ERL - Ronnie Pearson)

LANGUAGE: FORTRAN IV

COMPUTER: SEL 32/55

SPECIAL PERIPHERALS: 1 Tape Drive
Disk Files

PURPOSE/DESCRIPTION: CLUST is structurally similar to the SEARCH program for unsupervised development of class signatures. CLUST, however, uses a Euclidean distance measure in its sort and merge control logic for clusters. CLUST is often more useful than SEARCH in very broken terrain where fields of 40 acres are not common.

PROGRAM NAME: SUPERG (NASA/ERL - Marcellus Graham)

LANGUAGE: FORTRAN IV

COMPUTER: SEL 32/55

SPECIAL PERIPHERALS: 2 Tape Drives
Disk Files

PURPOSE/DESCRIPTION: SUPERG is a rectification program for Landsat MSS data which includes 2nd order mirror corrections into a least squares determination of a covariance matrix for conversion of Landsat pixels into a UTM coordinate system. The data are resampled along scan lines to satisfy scaling considerations and the output file contains new pixels which are directly related to the UTM system. Between 10 and 30 Ground Control Points are suggested for complete determination of the transformation. Rotation of the data to true North is not accomplished by this program.

PROGRAM NAME: TRAIN

LANGUAGE: FORTRAN IV

COMPUTER: Data General NOVA II

SPECIAL PERIPHERALS: COMTAL Interactive Color Video Display (3 images)
Magnetic Tape Drive
Disk Files

PURPOSE: TRAIN is an interactive training field selection and statistics generation program for Landsat digital analysis. In conjunction with a video display system with a cursor or joystick, a subset of a Landsat image may be selected by drawing an arbitrarily shaped polygon (up to 100 vertices) around an area on the display screen. The program keeps track of position on the input Goddard format CCT and calculates the normal statistics (mean and covariance) of the selected training fields. Histograms of the multivariate distribuitons are displayed on the display screen and the mean and variance, polygon vertices, and histograms may be saved on a disk file. The program acts in a question-answer mode which requires no knowledge of computer languages by the user.

A parallelopiped classifier is also implemented in this program which will classify a 256 x 256 element scene for one class in near real time.

APPENDIX B

PROGRAM LISTINGS

```
C*************************************************************************:
C                                                                         :
C        ADDSIGM                                                          :
C                                                                         :
C        THIS ROUTINE ADDS SPECIFIED SIGNATURES                           :
C        TO FORM NEW MEAN AND COVARIANCE                                  :
C                                                                         :
C        SEQUENCE:  ADDSIGM INPUT SIGFIL NEWSIG                           :
C                                                                         :
C*************************************************************************:
C                                                                         :
C        CREATED AT GEORGIA TECH EES                                      :
C                                                                         :
C        PROGRAMMER:  NICKOLAS L. FAUST                                   :
C                                                                         :
C*************************************************************************:
      DIMENSION COV1(4,4),COV2(4,4),NUM1(12),NUM2(12),IORDER(60)
      DIMENSION ID(6),AMEAN(4,60),BCOV(4,4,60),I1(30),I2(30),I3(30)
      DIMENSION NP(60),NAM1(60),NAM2(60),NAM3(60),NAM4(60)
      DIMENSION VM1(12),VM2(12),VM(4),ISW(2)
      COMMON/NPP/NP
      ND=4
      IP=12
C
C        COMARG AND OPEN STATEMENTS
C
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I2,ISW,IERR)
      CALL COMARG(1,I3,ISW,IERR)
      CALL OPEN(2,I1,0,IE)
      CALL FOPEN(4,I3,"B")
C
C
      TYPE "  INPUT NEWSIG NAME  "
      READ(11,200)N1,N2,N3,N4
      READ(2)NSIG
      WRITE(IP)NSIG
C
C        GET SIGNATURES LISTED IN INPUT FILE
C
      CALL GSIG(AMEAN,BCOV,NSIG,2,3,I2,IORDER,NAM1,NAM2,NAM3,NAM4)
      NUM1(1)=NP(1)
      DO (J=1,4)
      :  VM1(J)=AMEAN(J,1)
      :  DO (L=1,4)
      :  :   COV1(J,L)=BCOV(J,L,1)
      :  :..FIN
      :..FIN
      NS1=NSIG-1
```

```
C
C         LOOP TO COMBINE NSIG SIGNATURES
C
      DO (K=1,NS1)
      :   KP1=K+1
      :   DO (J=1,4)
      :   :   VM2(J)=AMEAN(J,KP1)
      :   :   DO (L=1,4)
      :   :   :   COV2(J,L)=BCOV(J,L,KP1)
      :   :   :..FIN
      :   :..FIN
      :   NUM2(1)=NP(KP1)
C     :
C     :
      :   CALL ADDSIG(COV1,COV2,VM1,VM2,ND,NUM1,NUM2)
C     :
C     :
      :..FIN
      DO (I=1,4)
      :   VM(I)=VM1(I)
      :..FIN
      WRITE(IP,201)N1,N2,N3,N4
      WRITE(IP)NUM1(1),VM,COV1
      DO (L=1,6) ID(L)=0
      WRITE BINARY(4) ID
      WRITE BINARY(4)N1,N2,N3,N4
      WRITE BINARY(4)NUM1(1),VM,COV1
200   FORMAT(4A2)
201   FORMAT(2X,4A2)
      STOP
      END
```

```
C*****************************************************************************:
C                                                                             :
C        ALARM   (SUBROUTINE)                                                 :
C                                                                             :
C        THIS SUBROUTINE ALARMS 1 CLASS ON THE COMTAL                         :
C        CORRESPONDING TO THE LAST SIGNATURE,                                 :
C        IT ALARMS TO GRAPHICS OVERLAY #IOV                                   :
C                                                                             :
C*****************************************************************************:
C                                                                             :
C        CREATED AT GEORGIA TECH EES                                          :
C                                                                             :
C        PROGRAMMERS:  NICKOLAS L. FAUST                                      :
C                      ROBERT A. MADDOX                                       :
C                                                                             :
C*****************************************************************************:
      SUBROUTINE ALRM2(IOV)
      DIMENSION IMIN(4),IMAX(4),IX2(0:255,3)
      COMMON/DTRANS/IMAG1(0:255),IXD(0:511,4),IMAG(0:511)
      COMMON/HISTX/ICOUNT(4,100)
      EQUIVALENCE (IXD,IX2)
      DO (I=0,15) IMAG(I)=0
      DO (I=0,255) CALL GWR(IOV,I,IMAG,16)
      DO (I=1,4)
      :  DO (J=1,100)
      :  :  IF(ICOUNT(I,J).GT.0)GO TO 30
      :  :..FIN
30    :  CONTINUE
      :  IMIN(I)=J
      :  DO (JJ=1,100)
      :  :  N=101-JJ
      :  :  IF(ICOUNT(I,N).GT.0)GO TO 50
      :  :..FIN
50    :  CONTINUE
      :  IMAX(I)=N
      :..FIN
      IMIN1=IMIN(1)
      IMIN2=IMIN(2)
      IMIN4=IMIN(4)
      IMAX1=IMAX(1)
      IMAX2=IMAX(2)
      IMAX4=IMAX(4)
      DO (K=0,255)
      :  CALL IMRD(0,K,IMAG(0),128)
      :  CALL IMRD(1,K,IMAG(128),128)
      :  CALL IMRD(2,K,IMAG(256),128)
      :  CALL UPAC8(IMAG, IX2(0,1), 384)
      :  DO (L=0,255)
      :  :  IMAG1(L)=0
      :  :  IF (IX2(L,1).LT.IMIN1) GOTO 70
      :  :  IF (IX2(L,1).GT.IMAX1) GOTO 70
      :  :  IF (IX2(L,2).LT.IMIN2) GOTO 70
      :  :  IF (IX2(L,2).GT.IMAX2) GOTO 70
      :  :  IF (IX2(L,3).LT.IMIN4) GOTO 70
      :  :  IF (IX2(L,3).GT.IMAX4) GOTO 70
      :  :  IMAG1(L)=1
70    :  :  CONTINUE
      :  :..FIN
      :  CALL PACB(IMAG1,IMAG,16)
      :  CALL GWR(IOV,K,IMAG,16)
      :..FIN
      RETURN
      END
```

```
C***********************************************************************
C                                                                      *
C       ANGDIS   (SUBROUTINE)                                          *
C                                                                      *
C       PURPOSE:                                                       *
C       COMPUTES THE DISTANCES AND ANGLES BETWEEN A SET OF             *
C       VECTORS OF ARBITARY DIMENSION                                  *
C                                                                      *
C       DESCRIPTION OF PARAMETERS                                      *
C                                                                      *
C       INPUT:                                                         *
C       CALLING SEQUENCE                                               *
C       VM - NVM VECTORS OF DIMENSION ND , STORED BY COLUMNS           *
C       NVM - NUMBER OF VECTORS                                        *
C       ND - DIMENSION OF EACH VECTOR                                  *
C       IDISF - .EQ.1 COMPUTE EUCLIDEAN DISTANCE                       *
C               .NE.1 COMPUTE L1 DISTANCE                              *
C       OUTPUT                                                         *
C       CALLING SEQUENCE                                               *
C       R - AN NVM BY NVM MATRIX WITH I TH - J TH ELEMENT              *
C       CORRESPONDING TO I TH - J TH VECTORS AND EQUALS ANGL           *
C       IF ABOVE DIAGONAL AND EQUALS DISTANCE IF BELOW                 *
C       DIAGONAL                                                       *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT NASA/JSC  (ASTEP)                                   *
C                                                                      *
C***********************************************************************
      SUBROUTINE ANGDIS(VM,NVM,ND,IDISF,R)
      DIMENSION VM(ND,NVM),R(NVM,NVM)
      N = NVM - 1
      DO 20 J = 1,N
      R(J,J) = 0.
      I1 = J + 1
      DO 10 I = I1,NVM
      IF(IDISF.EQ.1) GO TO 6
      D=0.
      DO 4 K=1,ND
    4 D=D+ABS(VM(K,J)-VM(K,I))
      GO TO 8
    6 CALL EDIST(VM(1,J),VM(1,I),ND,D)
    8 CONTINUE
      CALL ANGLE(VM(1,J),VM(1,I),ND,A)
      R(I,J) = D
      R(J,I) = A
   10 CONTINUE
   20 CONTINUE
      R(NVM,NVM) = 0.
      RETURN
      END
```

```
C***********************************************************************
C                                                                      *
C        ANGLE   (SUBROUTINE)                                          *
C                                                                      *
C        PURPOSE:                                                      *
C        COMPUTES THE ANGLE BETWEEN TWO VECTORS OF ARBITARY            *
C        DIMENSION                                                     *
C                                                                      *
C        DESCRIPTION OF PARAMETERS                                     *
C                                                                      *
C        INPUT                                                         *
C        CALLING SEQUENCE                                              *
C        V1 - 1 ST VECTOR                                              *
C        V2 - 2 ND VECTOR                                              *
C        ND - DIMENSION OF V1 AND V2                                   *
C                                                                      *
C        OUTPUT                                                        *
C        CALLING SEQUENCE                                              *
C        A - ANGLE BETWEEN V1 AND V2 IN DEGREES                        *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT NASA/JSC   (ASTEP)                                 *
C                                                                      *
C***********************************************************************
      SUBROUTINE ANGLE ( V1, V2, ND, A )
      DIMENSION V1(ND),V2(ND)
      D1 = 0.
      D2 = 0.
      A = 0.
      DO 10 I = 1,ND
      D1 = D1 + V1(I)**2
      D2 = D2 + V2(I)**2
   10 A = A + V1(I)*V2(I)
      IF ( D1.EQ.0.0 .OR. D2.EQ.0.0 )  GO TO 20
      A = A/(SQRT(D1)*SQRT(D2))
      A = 57.29578*ACOS( A )
   15 RETURN
   20 A = 90.0
      GO TO 15
      END
```

```
C***********************************************************************
C                                                                      *
C       AUTO811Z                                                       *
C                                                                      *
C       DESIGNED TO OUTPUT CLASSIFIED TAPE IN PATTERN FORMAT           *
C       TO DISPLAY ON THE VERSATEC                                     *
C                                                                      *
C       SEQUENCE:  AUTO811Z MTU:F INPUTFILE                            *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT GEORGIA TECH EES                                    *
C                                                                      *
C       PROGRAMMER:  MICHAEL D. FURMAN                                 *
C                                                                      *
C***********************************************************************
      INTEGER IMAG(180),ITAPE(10),IOUT(360),IORDER(25,15),ISW(2)
      INTEGER NC(25),IWORK(4100),IMAG3(180),IMEM(0:255),IMAG2(360)
      INTEGER IWORK1(360),IWORK2(360),IWORK3(360),IWORK4(360)
      INTEGER IWORK5(360),IWORK6(360),IWORK7(360),IWORK8(360)
      INTEGER IWORK9(360),IWORK10(360),IWORK11(360),IWORK12(360)
      INTEGER IMES(15,40),IFLD(10)
      EQUIVALENCE (IWORK(1),IWORK1(1))
      EQUIVALENCE (IWORK(359),IWORK2(1))
      EQUIVALENCE (IWORK(717),IWORK3(1))
      EQUIVALENCE (IWORK(1075),IWORK4(1))
      EQUIVALENCE (IWORK(1433),IWORK5(1))
      EQUIVALENCE (IWORK(1791),IWORK6(1))
      EQUIVALENCE (IWORK(2149),IWORK7(1))
      EQUIVALENCE (IWORK(2507),IWORK8(1))
      EQUIVALENCE (IWORK(2865),IWORK9(1))
      EQUIVALENCE (IWORK(3223),IWORK10(1))
      EQUIVALENCE (IWORK(3581),IWORK11(1))
      EQUIVALENCE (IWORK(3939),IWORK12(1))
      COMMON/DUM/ID(165),IWORK
      DATA ID/
     10,0,0,0,0,0,0,0,0,0,0,
     20,176K,102K,102K,102K,102K,102K,102K,102K,176K,0,
     30,0,176K,176K,176K,176K,176K,176K,176K,0,0,
     4300K,340K,160K,160K,60K,30K,14K,16K,16K,7,3,
     5176K,74K,30K,0,201K,303K,201K,0,30K,74K,176K,
     6303K,303K,303K,303K,0,0,0,303K,303K,303K,303K,
     730K,30K,30K,30K,30K,30K,30K,30K,30K,30K,30K,
     830K,30K,30K,30K,377K,377K,377K,30K,30K,30K,30K,
     93,7,16K,16K,14K,30K,60K,160K,160K,340K,300K,
     1377K,301K,241K,231K,231K,231K,231K,231K,205K,203K,377K,
     1201K,303K,347K,176K,74K,30K,74K,176K,347K,303K,201K,
     2374K,370K,361K,361K,363K,347K,317K,217K,217K,37K,77K,
     377K,37K,217K,217K,317K,347K,363K,361K,361K,370K,374K,
     4377K,377K,377K,303K,303K,303K,303K,303K,377K,377K,377K,
     5377K,377K,377K,377K,377K,377K,377K,377K,377K,377K,377K/
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,ITAPE,ISW,IERR)
      CALL COMARG(1,ITAPE,ISW,IERR)
      CALL COMARG(1,IFLD,ISW,IERR)
      CALL FOPEN(3,IFLD,"B")
```

```
      IO=3
      CALL MTOPD(2,ITAPE,0,IE)
      DO (I1=1,25)
      :   DO (I2=1,15) IORDER(I1,I2)=0
      :..FIN
      TYPE "DOES INPUT TAPE HAVE THRESHOLD? (2=YES,1=NO)"
      READ(IO) ITH
      TYPE "LINE"
      READ(IO) ILINE
      TYPE "MAP PORTION (1 - 12) ",IANS2
      READ(IO) IANS2
      TYPE "LENGTH OF DATA "
      READ(IO) IST
      IEND=IEL+359
      IF (IEND.GT.4100) IEND=4100
      TYPE "PRODUCE OVERALL MAP? (1=YES) "
      READ(IO) IANS
      TYPE "NUMBER OF GENERALIZED CLASSES "
      READ(IO) IGEN
      DO (I=1,IGEN)
      :   TYPE "INPUT CLASS DESCRIPTION "
      :   READ(IO,101) (IMES(I,K),K=1,20)
      :   TYPE "NUMBER OF SUBCLASSES "
      :   READ(IO) NC(I)
      :   NC1=NC(I)
      :   TYPE "INPUT SUBCLASSES "
      :   READ(IO) (IORDER(I,K),K=1,NC1)
      :   IF (I.NE.IGEN) TYPE "NEXT GROUP"
      :..FIN
50    DO (I=1,258) IMAG2(I)=0
      DO (I=1,180) IMAG3(I)=-1
      DO (I=0,255) IMEM(I)=0
      WRITE(12)
      L2=154
      DO (I=1,ILINE) CALL MTDIO(2,0,IWORK2,IS,IE,IC)
      IF (IANS.EQ.1)
      :   DO (I=1,180) IOUT(I)=0
      :   DO (M5=1,IGEN)
      :   :   L3=NC(M5)
      :   :   DO (J2=1,L3) IMEM(IORDER(M5,J2))=L2
      :   :   WRITE(12,100)(IMES(M5,K),K=1,20)(IORDER(M5,I),I=1,L3)
      :   :   DO (J=1,11)
      :   :   :   IOUT(15)=ID(L2+J)
      :   :   :   CALL MTX(IOUT,180)
      :   :   :..FIN
      :   :   L2=L2-11
      :   :..FIN
      :   WRITE(12)
      :..FIN
```

```
      DO (M1=1,IGEN)
      :   IF (IANS.NE.1)
      :   :   L3=NC(M1)
      :   :   WRITE(12,100)(IMES(M1,K),K=1,20)(IORDER(M1,I),I=1,L3)
      :   :   DO (I=1,180)  IOUT(I)=0
      :   :   DO (I=0,255)  IMEM(I)=0
      :   :   DO (J=1,11)
      :   :   :   L2=154
      :   :   :   DO (J2=1,L3)
      :   :   :   :   IMEM(IORDER(M1,J2))=L2
      :   :   :   :   IOUT(J2*4+9)=ID(L2+J)
      :   :   :   :   L2=L2-11
      :   :   :   :..FIN
      :   :   :   CALL MTX(IOUT,180)
      :   :   :..FIN
      :   :   WRITE(12)
      :   :..FIN
      :   DO (I=1,8) CALL MTX(IMAG3,180)
      :   DO (M2=1,IST)
      :   :   DO (I=1,ITH)
      :   :   :   CALL MTDIO(2,0,IWORK,IS,IE,IC)
      :   :   :   IF (IC.LT.5) GOTO 55
      :   :   :..FIN
      :   :   CONDITIONAL
      :   :   :   (IANS2.EQ.1) CALL AUTEC(IWORK1,IMEM,11)
      :   :   :   (IANS2.EQ.2) CALL AUTEC(IWORK2,IMEM,11)
      :   :   :   (IANS2.EQ.3) CALL AUTEC(IWORK3,IMEM,11)
      :   :   :   (IANS2.EQ.4) CALL AUTEC(IWORK4,IMEM,11)
      :   :   :   (IANS2.EQ.5) CALL AUTEC(IWORK5,IMEM,11)
      :   :   :   (IANS2.EQ.6) CALL AUTEC(IWORK6,IMEM,11)
      :   :   :   (IANS2.EQ.7) CALL AUTEC(IWORK7,IMEM,11)
      :   :   :   (IANS2.EQ.8) CALL AUTEC(IWORK8,IMEM,11)
      :   :   :   (IANS2.EQ.9) CALL AUTEC(IWORK9,IMEM,11)
      :   :   :   (IANS2.EQ.10) CALL AUTEC(IWORK10,IMEM,11)
      :   :   :   (IANS2.EQ.11) CALL AUTEC(IWORK11,IMEM,11)
      :   :   :   (IANS2.EQ.12) CALL AUTEC(IWORK12,IMEM,11)
      :   :   :..FIN
      :   :..FIN
55    :   DO (I=1,11) CALL MTX(IMAG3,180)
      :   DO (I=1,700)
      :   :   DO (J=1,360) IOUT(J)=ID(1)
      :   :   DO (N10=1,1100) N11=N10
      :   :   CALL PAC8(IOUT,IMAG,360)
      :   :   CALL MTX(IOUT,180)
      :   :..FIN
      :   CALL MTDIO(2,10000K,IWORK,IS,IE,IC)
      :   DO (I=1,ILINE) CALL MTDIO(2,0,IWORK2,IS,IE,IC)
      :   IF (IANS.EQ.1)
      :   :   IANS=0
      :   :   GOTO 50
      :   :..FIN
      :..FIN
      DO (I=1,10) WRITE(12)
      STOP FINISHED
100   FORMAT(1X,/,1X,20A1,/," CLASSES ",20I4)
101   FORMAT(20A1)
      END
```

```
C*****************************************************************************
C
C         CHAN24
C
C         UNPACKS AND REFORMATS BENDIX 24-CHANNEL DATA FOR DISPLAY
C
C         SEQUENCE CHAN24 MTU:F MTU:F
C
C*****************************************************************************
C
C         CREATED AT GEORGIA TECH EES
C
C         PROGRAMMER:  MICHAEL D. FURMAN
C
C*****************************************************************************
      INTEGER IDATA(4100),IMAG(512),IMAG2(256),ITAPE1(5),ITAPE2(5)
      INTEGER IWORK(256),IHEAD(30),IX(3),IY(3),ISW(2)
      COMMON IX,IY
      EQUIVALENCE (IX(1),IX1),(IX(2),IX2),(IY(1),IY1),(IY(3),IY3)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,ITAPE1,ISW,IERR)
      CALL COMARG(1,ITAPE1,ISW,IERR)
      CALL COMARG(1,ITAPE2,ISW,IERR)
      DO (I=1,30) IHEAD(I)=0
C
 10   FORMAT(1X,I2,"/",I2,"/",I2)
 11   FORMAT(1X,"INPUT TAPE NO.",Z)
 12   FORMAT(1X,10A2)
 13   FORMAT(1X,"BLOCK SIZE= ",I3)
 14   FORMAT(10A2)
C
      TYPE "DATE M,D,Y"
      ACCEPT IHEAD(3),IHEAD(4),IHEAD(5)
      TYPE "INPUT TAPE NUMBER? XXXX"
      ACCEPT IHEAD(1)
      TYPE "COMMENTS ON RUN -- 20 CHARACTERS"
      READ(11,14)(IHEAD(I),I=10,20)
      CALL COLORSUB
      TYPE "FAST SCAN? (2=YES, 1=NO)"
      ACCEPT IFSCAN
      TYPE "DATA BLOCKS TO SKIP?"
      ACCEPT ISKB
      TYPE "INPUT BLOW-UP FACTOR"
      ACCEPT IBLUP
      IBLUPM1=IBLUP-1
```

```
    IELEM=1
    IF (IFSCAN.EQ.1)
    :   TYPE "START WITH ELEMENT?"
    :   ACCEPT IELEM
    :..FIN
    CALL SCALESUB
    TYPE "INPUT CHANNEL NUMBER(1-24)"
    ACCEPT ICHAN
    ISKB=(ICHAN+2)/3+(ISKB*9)+2
    INUM=5+ICHAN-(((ICHAN+2)/3+1)*3)
    L=INUM*393+2+IELEM
    LAST=L+256+((IFSCAN-1)*92)
    IF (IELEM.GT.94) LAST=351+(INUM*393)
    CALL MTOPD(3,ITAPE1,0,IER)
    CALL MTOPD(4,ITAPE2,0,IER)
    DO (I=1,ISKB) CALL MTDIO(3,0,IDATA,IS,IER,ICNT)
    M2=512/IBLUP
    M3=0
    DO (M1=1,M2)
    :   DO (N=1,IFSCAN)
    :   :   CALL MTDIO(3,30010K,IDATA,IS,IE,IC)
    :   :   CALL MTDIO(3,0,IDATA,IS,IE,IC)
    :   :   IF (IC.LT.10) GOTO 150
    :   :..FIN
    :   J=1
    :   DO (K=L,LAST,IFSCAN)
    :   :   IMAG(J)=IDATA(K)
    :   :   J=J+1
    :   :..FIN
    :   BLOWUP-AREA
    :   DO (I=1,IBLUP)
    :   :   CALL IMWRITE(0,M3,IMAG2,256)
    :   :   M3=M3+1
    :   :..FIN
    :..FIN
150 DO (L1=1,3)
    :   PAUSE -- POSITION CURSER AND HIT RETURN
    :   CALL RTARG(IX(L1),IY(L1))
    :..FIN
    IX1=IX1/2
    IX2=IX2/2
    DO (I=1,3,2)
    :   CALL IMREAD(0,IY(I),IWORK,256)
    :   DO (I2=IX1,IX2) IWORK(I2)=255
    :   CALL IMWRITE(0,IY(I),IWORK,256)
    :..FIN
    DO (I=IY1,IY3)
    :   CALL IMREAD(0,I,IWORK,256)
    :   IWORK(IX1)=255
    :   IWORK(IX2)=255
    :   CALL IMWRITE(0,I,IWORK,256)
    :..FIN
```

```
      TYPE "PROPER RECTANGLE? (1=YES; 2=NO)"
      ACCEPT IANS
      IF (IANS.EQ.2) GOTO 150
      CALL MTDIO(3,10000K,IDATA,IS,IE,ICNT)
      IX1=IX1*IFSCAN+IELEM-1
      IX2=IX2*IFSCAN+IELEM-1
      IY1=IY1*IFSCAN
      IY3=IY3*IFSCAN
      IPAS=9*IY1
      IDIF=(IY3-IY1)
      IDIF2=IX2-IX1
      WRITE-HEADER
      CALL MTDIO(3,30001K+IPAS,IDATA,IS,IE,ICNT)
      DO (I=1,IDIF)
      :  CALL MTDIO(3,30001K,IDATA,IS,IE,ICNT)
      :  DO (K5=1,8)
      :  :  CALL MTDIO(3,0,IDATA,IS,IE,ICNT)
      :  :  DO (L6=3,789,393)
      :  :  :  J=1
      :  :  :  DO (L5=IX1,IX2)
      :  :  :  :  IWORK(J)=IDATA(L5+L6)
      :  :  :  :  J=J+1
      :  :  :  :..FIN
      :  :  :  CALL MTDIO(4,50000K+IDIF2,IWORK,IS,IE,ICNT)
      :  :  :..FIN
      :  :..FIN
      :..FIN
      DO (I=1,10) CALL MTDIO(4,60000K,IWORK,IS,IE,ICNT)
      CALL MTDIO(4,10000K,IWORK,IS,IE,ICNT)
      CALL MTDIO(3,10000K,IDATA,IS,IE,ICNT)
      STOP
C
      TO WRITE-HEADER
      :  WRITE(12,11)
      :  WRITE(12) IHEAD(1)
      :  WRITE(12,10) IHEAD(3),IHEAD(4),IHEAD(5)
      :  WRITE(12,12)(IHEAD(I),I=10,20)
      :  WRITE(12,13)IDIF2
      :  CALL MTDIO(4,50036K,IHEAD,IS,IE,ICNT)
      :..FIN
C
      TO BLOWUP-AREA
      :  DO (K7=0,255)
      :  :  K9=256-K7
      :  :  KDB=K9/IBLUP
      :  :  IMAG(K9)=IMAG(KDB)
      :  :..FIN
      :  CALL PAC8(IMAG,IMAG2,512)
      :..FIN
200   STOP FIELD ERROR -- CHAN24 MTU:F MTU:F
      END
```

```
C***********************************************************************
C                                                                      *
C        CLASIFY                                                       *
C                                                                      *
C        THIS ROUTINE CLASSIFIES POLYGONS WITH A MAXLIK CLASSIFIER     *
C        A TABLE LOOK-UP FEATURE IS INCLUDED                           *
C                                                                      *
C        SEQUENCE:  CLASIFY INPUT DATAP MAXTAP SIGFIL                  *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT GEORGIA TECH EES                                   *
C                                                                      *
C        PROGRAMMERS:  NICKOLAS L. FAUST                               *
C                      ROBERT A. MADDOX                                *
C                                                                      *
C***********************************************************************
      DIMENSION AMEAN(4,60),BCOV(4,4,60),IVX(101),IVY(101),DET(60)
     1,LA(133),COUNT(0:61),IBUF(1640),CLCON(61)
     2,NAM1(60),NAM2(60),NAM3(60),NAM4(60),B1(4,4),B2(4,4)
      DIMENSION JBUF(4,810),FIELD(17),ISWS(2),IORD(0:61)
      DIMENSION DUM(61),DUM1(4,4,60),DUM2(4,60),ITABL(5,300)
      COMMON JBUF
      EQUIVALENCE (JBUF,DUM),(JBUF,DUM1),(JBUF,DUM2),(JBUF(1,20),DET),
     1(JBUF,B1),(JBUF(1,10),B2)
C
C        COMARG CALLS  AND OPEN STATEMENTS
C
      CALL OPEN(1,"COM.CM",1,IE)
      CALL COMARG(1,FIELD,ISWS,IE)      ;GET PROGRAM NAME
      CALL COMARG(1,FIELD,ISWS,IE)      ;GET INPUT FILE NAME
      CALL OPEN(2,FIELD,0,IE)           ;OPEN INPUT FILE
      CALL COMARG(1,FIELD,ISWS,IE)      ;GET DATA TAPE NAME
      CALL MTOPD(3,FIELD,0,IE)          ;OPEN TAPE FILE
      CALL COMARG(1,FIELD,ISWS,IE)      ;GET OUTPUT TAPE NAME
      CALL MTOPD(5,FIELD,0,IE)          ;OPEN TAPE OUTPUT FILE
      CALL COMARG(1,FIELD,ISWS,IE)      ;GET SIGNATURE FILE NAME
C
C
      IP=12
      ND=4
      BNV=-1.E+12                 ;BIG NEGATIVE NUMBER
      ITPTR=0                     ;INITIAL TABLE POINTER
      READ(2,200)NSIG
C
C        GET SIGNATURES  FOR CLASSIFICATION
C
      CALL GSIG(AMEAN,BCOV,NSIG,FIELD,NAM1,NAM2,NAM3,NAM4,CLCON)
      DO (L=1,NSIG)
      :  DO (JH=1,4)
      :  :  DO (JI=1,4)
      :  :  :  B2(JH,JI)=BCOV(JH,JI,L)
      :  :  :..FIN
      :  :..FIN
      :  CALL SYMINV(B2,B1,DETP,4)
      :  DO (JH=1,4)
      :  :  DO (JI=1,4)
      :  :  :  BCOV(JH,JI,L)=B1(JH,JI)
      :  :  :..FIN
      :  :..FIN
C     :    DIVIDE DIAGONAL ENTRIES OF COVARIANCE MATRIX BY TWO
      :  DO (J=1,4)  BCOV(J,J,L) = BCOV(J,J,L)/2.
C     :    GET NATURAL LOG OF DETERMINANT
      :  DET(L)=ALOG(DETP)
      :..FIN
```

```
C
      IYMIN=10000
      IXMIN=10000
      IYMAX=0
      WRITE(IP,202)
      READ(2,200)NC
      DO (I=1,NC)
      :   WRITE(IP,205)I
      :   READ(2,206)IVX(I),IVY(I)
      :   WRITE(IP,206)IVX(I),IVY(I)
      :   IF(IVY(I).LT.IYMIN)IYMIN=IVY(I)
      :   IF(IVX(I).LT.IXMIN)IXMIN=IVX(I)
      :   IF(IVY(I).GT.IYMAX)IYMAX=IVY(I)
      :..FIN
      IVX(NC+1)=IVX(1)
      IVY(NC+1)=IVY(1)
      NV=NC
      IDEL=IYMAX-IYMIN
      ISKIP=IYMIN+1
C
C       SET UP THE APRIORI INFORMATION EITHER FROM,
C               A. THE INPUT FILE IF 'IAPR' EQUALS 1 IN INPUT FILE
C          OR   B. SET APRIORI FOR ALL CLASSES EQUAL TO 1.0
C
      READ (2,201) NTE          ;NUMBER OF TABLE ENTRIES

      READ (2,200) ITH
      IF (ITH.NE.0)
      :   READ (2,310) THRS
      :   THRS=ALOG(THRS)
      :..FIN
      READ (2,200) IAPR
      IF (IAPR.EQ.0)
      :   DO (I=1,NSIG) CLCON(I)=1.
      :..FIN
      WRITE(IP,410)
      DO (I=1,NSIG)
      :   WRITE(IP,420) I,NAM1(I),NAM2(I),NAM3(I),NAM4(I),CLCON(I)
      :..FIN
      WRITE(IP,400)
C
C       COMPUTE CLASS CONSTANTS
C
      PILOG=2.*ALOG(2.*3.141593)
      DO (I=1,NSIG) CLCON(I)=ALOG(CLCON(I))-.5*DET(I)-PILOG
      CLCON(NSIG+1) = BNV
C
C       SORT CLASS CONSTANTS FROM LARGEST TO SMALLEST
C               AND ALSO REORDER STATISTICS
C
      DO (J=1,NSIG)
      :   BG = -1.E+10
      :   DO (I=1,NSIG)
      :   :   IF (CLCON(I).GT.BG)
      :   :   :   BG=CLCON(I)
      :   :   :   IND=I
      :   :   :..FIN
      :   :..FIN
      :   IORD(J)=IND
      :   DUM(J)=CLCON(IND)
      :   CLCON(IND)=BNV
      :..FIN
      IORD(61)=61
      IORD(0)=0
```

```
C
C        REORDER CLASS CONSTANT ARRAY
C
      DO (J=1,NSIG)   CLCON(J)=DUM(J)
      CLCON(NSIG+1)=  BNV
C
C        REORDER COVARIANCE MATRICES
C
      DO (I=1,NSIG)
      :  DO (J=1,ND)
      :  :   DO (K=1,ND)   DUM1(J,K,I) = BCOV(J,K,IORD(I))
      :  :..FIN
      :..FIN
      DO (I=1,NSIG)
      :  DO (J=1,ND)
      :  :   DO (K=1,ND)   BCOV(J,K,I)=DUM1(J,K,I)
      :  :..FIN
      :..FIN
C
C        REORDER MEAN VECTORS
C
      DO (I=1,NSIG)
      :  DO (J=1,ND)   DUM2(J,I)=AMEAN(J,IORD(I))
      :..FIN
      DO (I=1,NSIG)
      :  DO (J=1,ND)   AMEAN(J,I)=DUM2(J,I)
      :..FIN
C
C        SKIP RECORDS
C
      CALL MTDIO(3,30000K+ISKIP,IBUF,IS,IEE)
      DO (LL=1,812)  IBUF(LL)=0
      IBUF(1)=IDEL
      IBUF(2)=IXMIN
      CALL MTDIO(5,50000K+810,IBUF,IS,IER,NW)
      ISW=2
      JQ=810
      TOT=0
      TOTHITS=0
      DO (I=0,61)  COUNT(I)=0
      DO (I=1,5)
      :  DO (J=1,NTE)
      :  :   ITABL(I,J)=0
      :  :..FIN
      :..FIN
      CALL FGTIME(IHR,IMIN,ISEC)
      TYPE "LINE PROCESSING BEGAN @",IHR,IMIN,ISEC
      DO (J=1,IDEL)
      :  HITS=0
      :  CALL MTDIO(3,0,IBUF,IS,IE,NW)
      :  CALL POLY2(ISKIP+J-1,ISW,IVX,IVY,NV,LA)
      :  JD=0
      :  DO (KO=1,JQ)
      :  :   DO (KP=1,4)
      :  :   :   JBUF(KP,KO)=0
      :  :   :..FIN
      :  :..FIN
      :  LA1=LA(1)
      :  DO (K1=1,LA1)
      :  :   LSUB=2*K1
      :  :   L2=LSUB+1
      :  :   JS=LA(LSUB)
      :  :   JF=LA(L2)
      :  :   JD=JD+JF-JS+1
      :  :   IF(JF.GT.JQ)  JF=JQ
      :  :   DO (K2=1,4)
      :  :   :   LL=((JS-1)/2)*4+K2
      :  :   :   LAST=LL+(JF-JS+1)*2
      :  :   :   J1=1
      :  :   :   DO (II=LL,LAST,4)
      :  :   :   :   JBUF(K2,J1)=ISHFT(IBUF(II),-8)
      :  :   :   :   JBUF(K2,J1+1)=IAND(IBUF(II),377K)
      :  :   :   :   J1=J1+2
      :  :   :   :..FIN
      :  :   :..FIN
      :  :..FIN
```

```
C
C         CLASSIFY THE POINTS BY MAXIMUM LIKLIHOOD ALGORITHM
C
       :  DO (JPT=1,JQ)
       :  :  IF (JBUF(1,JPT).EQ.0) GOTO 1000
       :  :  JB1=JBUF(1,JPT)
       :  :  JB2=JBUF(2,JPT)
       :  :  JB3=JBUF(3,JPT)
       :  :  JB4=JBUF(4,JPT)
       :  :  DO 1010 IC=1,NTE
       :  :  IF (JB3.NE.ITABL(3,IC)) GOTO 1010
       :  :  IF (JB2.NE.ITABL(2,IC)) GOTO 1010
       :  :  IF (JB4.NE.ITABL(4,IC)) GOTO 1010
       :  :  IF (JB1.NE.ITABL(1,IC)) GOTO 1010
       :  :  INDEX=ITABL(5,IC)
       :  :  HITS=HITS+1
       :  :  GOTO 1050
1010   :  :  CONTINUE
       :  :  M=1
       :  :  PROB=BNV
1040   :  :  VD1=JB1-AMEAN(1,M)
       :  :  VD2=JB2-AMEAN(2,M)
       :  :  VD3=JB3-AMEAN(3,M)
       :  :  VD4=JB4-AMEAN(4,M)
       :  :  CLTHR=CLCON(M) - (VD1*VD1*BCOV(1,1,M)
      1:  :                 +VD2*(VD1*BCOV(2,1,M)+VD2*BCOV(2,2,M))
      2:  :                 +VD3*(VD1*BCOV(3,1,M)+VD2*BCOV(3,2,M)
      2:  :                      +VD3*BCOV(3,3,M))
      3:  :                 +VD4*(VD1*BCOV(4,1,M)+VD2*BCOV(4,2,M)
      4:  :                      +VD3*BCOV(4,3,M)+VD4*BCOV(4,4,M)))
       :  :  IF (CLTHR.LT.PROB) GOTO 1020
       :  :  PROB=CLTHR
       :  :  INDEX=M
1020   :  :  M=M+1
       :  :  IF (PROB.LT.CLCON(M)) GOTO 1040
       :  :  IF (ITH.EQ.0)         GOTO 1030
       :  :  IF (PROB.LT.THRS)  INDEX=61
1030   :  :  ITPTR=ITPTR+1
       :  :  IF (ITPTR.GT.NTE) ITPTR=1
       :  :  ITABL(1,ITPTR)=JB1
       :  :  ITABL(2,ITPTR)=JB2
       :  :  ITABL(3,ITPTR)=JB3
       :  :  ITABL(4,ITPTR)=JB4
       :  :  ITABL(5,ITPTR)=INDEX
       :  :  GOTO 1050
1000   :  :  INDEX=0
1050   :  :  IBUF(JPT)=IORD(INDEX)
       :  :..FIN
C      :
C      :
       :  TOT=TOT+JD
       :  TOTHITS=TOTHITS+HITS
       :  DO (K=1,JQ)
       :  :  IBK=IBUF(K)
       :  :  COUNT(IBK)=COUNT(IBK)+1
       :  :..FIN
       :  CALL FGTIME(IHR,IMIN,ISEC)
       :  WRITE(10,207)J,HITS
       :  TYPE "TIME = ",IHR,IMIN,ISEC
       :  CALL MTDIO(5,50000K+810,IBUF,IS,IER)
       :..FIN
```

```
      WRITE(IP,400)
      WRITE(IP,430)
      DO (K=1,NSIG)
      :   PER=(COUNT(K)*100)/TOT
      :   IKK=IORD(K)
      :   WRITE(IP,440)K,NAM1(K),NAM2(K),NAM3(K),NAM4(K),IKK
     1:   CLCON(IKK),COUNT(K),PER
      :..FIN
      WRITE(IP,450) COUNT(61)
      WRITE(IP) TOTHITS,TOT
      WRITE(IP,400)
      DO (KL=1,810)   IBUF(KL)=0
      DO (KL=1,200) CALL MTDIO(5,50000K+810,IBUF,IS,IER)
      CALL MTDIO(5,60000K,IBUF,IS,IER)
      CALL MTDIO(5,60000K,IBUF,IS,IER)
      TYPE "TOTAL HITS, TOTAL POINTS ",TOTHITS,TOT

200   FORMAT(I2)
201   FORMAT(I3)
202   FORMAT(2X,"INPUT # OF CORNERS")
205   FORMAT(2X,"INPUT CORNER # ",I3,"J,I")
206   FORMAT(2I4)
207   FORMAT(2X,"LINE #",I5," PROCESSED   THERE WERE ",F8.0," HITS")
310   FORMAT(F10.6)
400   FORMAT(/////////////////)
410   FORMAT(2X,"NUMBER",2X,"NAME",6X,"APRIORI")
420   FORMAT(4X,I2,2X,4A2,2X,F10.6)
430   FORMAT(2X,"NUMBER  NAME  RANKING  CONSTANT   # PIXELS  PERCENT")
440   FORMAT(4X,I2,2X,4A2,3X,I2,2X,F10.6,2X,F8.1,3X,F5.1)
450   FORMAT(//,4X,"TOTAL POINTS NOT CLASSIFIED = ",F10.0,//)

      STOP
      END
```

```
C***************************************************************************
C                                                                          :
C         CLEANUP                                                          :
C                                                                          :
C         USED TO CLEAN UP SIGNATURE , VERTEX , OR HIST FILES              :
C                                                                          :
C         SEQUENCE:  CLEANUP NAMES FILEIN FILEOUT                          :
C                                                                          :
C**************************************************************************:
C                                                                          :
C         CREATED AT GEORGIA TECH EES                                      :
C                                                                          :
C         PROGRAMMER:  NICKOLAS L. FAUST                                   :
C                                                                          :
C**************************************************************************:
      DIMENSION IFIL(20),JFIL(20),KFIL(20),SM(4),COV(4,4),I(6)
      DIMENSION ICOUNT(4,100),IVX(101),IVY(101),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,JFIL,ISW,IERR)
      CALL COMARG(1,KFIL,ISW,IERR)
      CALL FOPEN(2,IFIL,"B")
      CALL FOPEN(4,KFIL,"B")
      WRITE(10,401)
      READ(11)ICON
      CALL FOPEN(3,JFIL,"B")
      READ BINARY(3)I
      WRITE BINARY(4)I
      CALL FCLOSE(3)
      FOREVER
      :  CALL FOPEN(3,JFIL,"B")
      :  READ BINARY(3)I
      :  ISW=0
      :  READ(2,100,END=121)NA1,NA2,NA3,NA4
      :  REPEAT WHILE(ISW.EQ.0)
      :  :  READ BINARY(3,END=120)NS1,NS2,NS3,NS4
      :  :  IF(ICON.EQ.1)READ BINARY(3)NP,SM,COV
      :  :  IF(ICON.EQ.2)
      :  :  :  READ BINARY(3)K,IYMIN,IYMAX
      :  :  :  DO (IV=1,K)READ BINARY(3)IVV,IVX(IV),IVY(IV)
      :  :  :..FIN
      :  :  IF(ICON.EQ.3)READ BINARY(3)ICOUNT
      :  :  IF((NS1.EQ.NA1).AND.(NS2.EQ.NA2))
      :  :  :  IF((NS3.EQ.NA3).AND.(NS4.EQ.NA4))
      :  :  :  :  WRITE BINARY(4)NS1,NS2,NS3,NS4
      :  :  :  :  IF(ICON.EQ.1)WRITE BINARY(4)NP,SM,COV
      :  :  :  :  IF(ICON.EQ.2)
      :  :  :  :  :  WRITE BINARY(4)K,IYMIN,IYMAX
      :  :  :  :  :  DO (IV=1,K)WRITE BINARY(4)IV,IVX(IV),IVY(IV)
      :  :  :  :  :..FIN
      :  :  :  :  IF(ICON.EQ.3)WRITE BINARY(4)ICOUNT
      :  :  :  :  ISW=1
      :  :  :  :  CALL FCLOSE(3)
      :  :  :  :..FIN
      :  :  :..FIN
      :  :..FIN
      :..FIN
      STOP
100   FORMAT(4A2)
401   FORMAT(2X,"INPUT SWITCH , 1 -SIG , 2 -VER , 3 -HIS")
120   STOP - SIGNATURE NOT FOUND
121   STOP - NORMAL EXIT
      END
```

```
C***********************************************************************
C                                                                      *
C        CLUSTA   (SUBROUTINE)                                         *
C                                                                      *
C     PURPOSE                                                          *
C              ADAPTIVE CLUSTERING ALGORITHM, 1-ST PASS THROUGH DEVELOP *
C              CLUSTER MEANS USING PERIODIC ELIMINATION TESTS AND       *
C              MERGER TESTS, ALSO HAS FEATURES OF STRIP FORMULATION AND *
C              SEQUENTIAL SEARCH FOR STRIP ASSIGNMENT, 2-ND PASS THROUG *
C              DEVELOPS CLASSIFICATION MAP                              *
C                                                                      *
C     DESCRIPTION OF PARAMETERS                                        *
C                                                                      *
C        INPUT                                                         *
C          CALLING SEQUENCE                                            *
C              V - VECTORS TO BE CLUSTERED                             *
C              VM - INITIAL CLUSTER MEANS                              *
C              ND - DIMENSION OF VECTORS                               *
C              NV - NUMBER OF VECTORS IN V                             *
C              NVM - NUMBER OF VECTORS IN VM                           *
C              NVMMAX - MAXIMUM NUMBER OF VECTORS ALLOWED IN VM        *
C              NVG - WEIGHTS FOR CLUSTERS, I-TH VALUE IS NUMBER OF     *
C                    POINTS IN I-TH CLUSTER                            *
C                                                                      *
C              C,S,RP,R - CLUSTERING DISTANCE MEASURES FOR MERGERS,    *
C                         STRIP GENERATION, PRIORITY SEARCH, AND       *
C                         THRESHOLD FOR NEW CLUSTERS RESPECTIVELY      *
C              NPC,NPT - COUNTER AND THRESHOLD FOR UPDATES TO PRIORITY *
C                        LIST                                          *
C              PLIST - PRIORITY LIST                                   *
C              NEC,NET - COUNTER AND THRESHOLD FOR SMALL CLUSTER       *
C                        ELIMINATION TESTS                             *
C              NMIN - ELIMINATION THRESHOLD, NUMBER OF POINTS          *
C              NMC,NMT - COUNTER AND THRESHOLD FOR MERGER TESTS        *
C              IPASS - PASS NUMBER OR ROUTING FLAG                     *
C              IP - PRINT FLAG, .EQ. 0 NO PRINT, .NE. 0 PRINT MERGERS  *
C                   AND ELIMINATION MESSAGES                           *
C              JPTP - NUMBER OF POINTS PROCESSED PRIOR TO THIS ENTRY   *
C              RMINM,RMINV - MEAN AND VARIANCE FOR CLUSTER THRESHOLD   *
C                            DISTANCES (USED FOR IPASS=2 ONLY), CURRENT *
C                            VALUES                                    *
C              VMP,VAR - MEANS AND VARIANCES DEVELOPED DURING 2-ND PASS *
C                        BASED UPON ACTUAL ASSIGNMENTS - CURRENT VALUES *
C                                                                      *
C        OUTPUT                                                        *
C          CALLING SEQUENCE                                            *
C              VM - UPDATED MEANS                                      *
C              NVM - NUMBER OF MEANS IN VM                             *
C              NVG - UPDATED WEIGHTS                                   *
C              IMG - DEFINES CLASSIFICATION MAP                        *
C              TDIS - THRESHOLD ARRAY                                  *
C              NPC,NEC,NMC - UPDATED VALUES                            *
C              RMINM,RMINV - UPDATED VALUES                            *
C              VMP,VAR - UPDATED VALUES                                *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT NASA/JSC   (ASTEP)                                 *
C                                                                      *
C***********************************************************************
      SUBROUTINE CLUSTA(V,VM,ND,NV,NVM,NVMMAX,NVG,C,S,RP,R,NPC,
     *NPT,PLIST,NEC,NET,NMIN,NMC,NMT,IPASS,IMG,TDIS,
     *IP,JPTP,RMINM,RMINV,VMP,VAR)
      COMMON/INOUT/NOUT,NIN
      INTEGER PLIST
      INTEGER TDIS,V
      DIMENSION V(ND,NV),VM(ND,NVMMAX),NVG(NVMMAX),PLIST(NVMMAX),
     *VS(24),IMG(NV),TDIS(NV)
      COMMON/DIST/IDIST
      DIMENSION RMINM(NVMMAX),RMINV(NVMMAX)
      DIMENSION VMP(ND,NVMMAX),VAR(ND,NVMMAX)
 1111 FORMAT(' ND ',I5)
      JPT=0
      NS=0
```

```
C
C                 TESTS ON - NEXT POINT, SMALL CLUSTER ELIMINATION,
C                            MERGING TIME, AND PLIST UPDATE TIME
C
   12 CONTINUE
      IF(IPASS.EQ.2) GO TO 16
      NEC=NEC+NS
      IF(NEC.GE.NET) GO TO 70
   14 NMC=NMC+NS
      IF(NMC.GE.NMT) GO TO 80
   16 NPC=NPC+NS
      IF(NPC.GE.NPT) GO TO 90
   18 JPT=JPT+1
      IF(JPT.GT.(NV-1)) GO TO 100
      JSC=JPT
      JPT=JPT+1
C
C                 STRIP GENERATION
C
   19 I=1
   20 T=IABS( V(I,JPT) - V(I,JSC) )
      IF ( T.GT.S )  GO TO 22
      I = I + 1
      IF ( I.LE.ND )  GO TO 20
      JPT = JPT + 1
      IF(JPT.LE.NV) GO TO 19
   22 JPT = JPT - 1
C
C                 COMPUTE MEAN OF STRIP
C
      NS=JPT-JSC+1
      DO 26 I=1,ND
   26 VS(I)=0.
      DO 30 J=JSC,JPT
      DO 28 I=1,ND
   28 VS(I)=VS(I)+V(I,J)
   30 CONTINUE
      T=FLOAT(NS)
      DO 32 I=1,ND
   32 VS(I)=VS(I)/T
C
C                 PRIORITY SEARCH FOR NEAREST CLUSTER
C
   34 RMIN=1.E+10
      DO 40 I=1,NVM
      L=PLIST(I)
      D=0.
      IF(IDIST.EQ.2)GO TO 3601
      DO 36 J=1,ND
   36 D=D+ABS(VM(J,L)-VS(J))
      GO TO 3602
 3601 CONTINUE
      DO 3603 J=1,ND
 3603 D=D+(VM(J,L)-VS(J))**2
      D=SQRT(D)
 3602 CONTINUE
 1112 FORMAT( )
      IF(D.GT.RMIN) GO TO 40
      RMIN=D
      J1=L
      IF(RMIN.LT.RP) GO TO 42
   40 CONTINUE
```

```
C
C               TEST DISTANCE TO CLUSTER FOR ASSIGNMENT OF STRIP
C
   42 IF(RMIN.GT.R) GO TO 50
C
C               FIRST PASS - ASSIGN TO J1
C
      IF(IPASS.EQ.2) GO TO 200
      CALL MODIFY(VM(1,J1),VS,NVG(J1),NS,ND)
      GO TO 12
C
C               FIRST PASS - NEW GROUP, POSSIBLE ELIMINATION OF SMALLEST
C
   50 IF(IPASS.EQ.2) GO TO 210
      NVM=NVM+1
      J1=NVM
      IF(NVM.LE.NVMMAX) GO TO 60
      NVM=NVMMAX
      NVGP=10000
      DO 52 I=2,NVM
      IF(NVG(I).GT.NVGP) GO TO 52
      IMIN=I
      NVGP=NVG(I)
   52 CONTINUE
      JPTT=JPTP+JPT
  900 FORMAT(9H CLUSTER ,I3,8H WEIGHT ,I4,19H ELIMINATED, JPT = ,I4,7H
     *VM = I3)
      NVG(1)=NVG(1)+NVG(IMIN)
      J1=IMIN
   60 DO 62 I=1,ND
   62 VM(I,J1)=VS(I)
      NVG(J1)=NS
      NPC=NPT
      GO TO 12
C
C               SMALL CLUSTER TESTS AND POSSIBLE ELIMINATIONS
C
   70 NEC=0
      NPC=NPT
      I=1
   72 I=I+1
   74 IF(I.GT.NVM) GO TO 14
      IF(NVG(I).GT.NMIN) GO TO 72
      JPTT=JPTP+JPT
      IF(IP.NE.0) WRITE(NOUT,900) I,NVG(I),JPTT,NVM
      NVG(1)=NVG(1)+NVG(I)
      CALL PACK(VM,ND,NVM,I)
      CALL PACK(NVG,1,NVM,I)
      NVM=NVM-1
      GO TO 74
C
C               TESTS FOR MERGING AND POSSIBLE MERGING
C
   80 NPC=NPT
      NMC=0
```

```
C
C
   82 I2=NVM-1
      IF(I2.LE.0) GO TO 16
      RMIN=1.E+10
      DO 88 I=1,I2
      I1=I+1
      DO 88 J=I1,NVM
      D=0.
      IF(IDIST.EQ.2)GO TO 8400
      DO 84 L=1,ND
   84 D=D+ABS(VM(L,I)-VM(L,J))
      GO TO 8401
 8400 CONTINUE
      DO 8402 L=1,ND
 8402 D=D+(VM(L,I)-VM(L,J))**2
      D=SQRT(D)
 8401 CONTINUE
 1007 FORMAT( )
      IF(D.GT.RMIN) GO TO 86
      RMIN=D
      J1=I
      J2=J
   86 CONTINUE
   88 CONTINUE
C
C                  THRESHOLD TEST
C
      IF(RMIN.GT.C) GO TO 16
C
C                  CLUSTER MERGING, J2 INTO J1
C
      JPTT=JPTP+JPT
      IF(IP.NE.0) WRITE(NOUT,902) J2,NVG(J2),J1,NVG(J1),NVM,JPTT
  902 FORMAT(7H MERGER,6H J2 = ,I2,7H NJ2 = ,I4,
     *6H J1 = ,I2,7H NJ1 = ,I4,7H NVM = ,I2,7H JPT = ,I4)
      CALL MODIFY(VM(1,J1),VM(1,J2),NVG(J1),NVG(J2),ND)
      CALL PACK(VM,ND,NVM,J2)
      CALL PACK(NVG,1,NVM,J2)
      NVM=NVM-1
      GO TO 82
C
C               PLIST UPDATE
C
   90 NPC=0
      CALL UPPLT(PLIST,NVG,NVM)
      GO TO 18
C
C               POSSIBLE SPECIAL CASE FOR LAST POINT
C
  100 IF(JPT.NE.NV) RETURN
      DO 102 I=1,ND
  102 VS(I)=V(I,NV)
      NS=1
      JSC=JPT
      GO TO 34
C
C               SECOND PASS - ASSIGN TO J1 AND UPDATE STATISTICS
C
  200 CALL THRDST(RMINM(J1),RMINV(J1),NVG(J1),RMIN,NS)
      DO 202 J=JSC,JPT
      CALL SEQST(VMP(1,J1),VAR(1,J1),NVG(J1),ND,V(1,J))
      TDIS(J)=RMIN
  202 IMG(J)=J1
      GO TO 12
C
C               SECOND PASS - ASSGN TO UNASSIGNED
C
 210  DO 212 J=JSC,JPT
      TDIS(J)=10000
 212  IMG(J)=1
      NVG(1)=NVG(1)+NS
      GO TO 12
      END
```

```
C***************************************************************************
C                                                                          *
C       COMBINE                                                            *
C                                                                          *
C       THIS PROGRAM COMBINES SIGNATURES                                   *
C       WITH A GIVEN SPECIFIER FROM TWO FILES                              *
C                                                                          *
C       SEQUENCE:  COMBINE FILE1 FILE2 FILE3                               *
C                                                                          *
C***************************************************************************
C                                                                          *
C       CREATED AT GEORGIA TECH EES                                        *
C                                                                          *
C       PROGRAMMER:  NICKOLAS L. FAUST                                     *
C                                                                          *
C***************************************************************************
      DIMENSION A(4,20),B(4,4,20),N11(20),N21(20),N31(20),N41(20)
      DIMENSION IF1(20),IF2(20),IF3(20),C(4.20),D(4,4,20)
      DIMENSION E(4,30),F(4,4,30),N12(20),N22(20),N32(20),N42(20)
      DIMENSION N1(30),N2(30),N3(30),N4(30)
      DIMENSION SM(4),COV(4,4),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IF1,ISW,IERR)
      CALL COMARG(1,IF1,ISW,IERR)
      CALL COMARG(1,IF2,ISW,IERR)
      CALL COMARG(1,IF3,ISW,IERR)
      NSIG=20
      WRITE(10,103)
      ND=4
      IP=10
      READ(11)ISW
      CALL FOPEN(2,IF1,"B")
      CALL FOPEN(3,IF2,"B")
      CALL FOPEN(4,IF3,"B")
      READ BINARY(2)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      IF(ISW.NE.1)READ BINARY(3) ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      WRITE(10,101)
      READ(11,100)NA1,NA2
      WRITE(10,102)
      NUN1=2
      READ(11,104)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      NSIG=5
      CALL GSIG1(A,B,NA1,NA2,NUM1,NSIG,NUN1,N11,N21,N31,N41)
      WRITE(12,105)
      NUN2=3
      NSIG=20
      IF(ISW.EQ.2)
      :  CALL GSIG1(C,D,NA1,NA2,NUM2,NSIG,NUN2,N12,N22,N32,N42)
      :  WRITE(12,106)
      :..FIN
```

```
      DO (K=1,NUM1)
      :  N1(K)=N11(K)
      :  N2(K)=N21(K)
      :  N3(K)=N31(K)
      :  N4(K)=N41(K)
      :  DO (K1=1,ND)
      :  :  E(K1,K)=A(K1,K)
      :  :  DO (K2=1,ND)
      :  :  :  F(K1,K2,K)=B(K1,K2,K)
      :  :  :..FIN
      :  :..FIN
      :..FIN
      IF(ISW.EQ.1)
      :  DO (M=1,NUM2)
      :  :  ML=NUM1+M
      :  :  N1(ML)=N12(M)
      :  :  N2(ML)=N22(M)
      :  :  N3(ML)=N32(M)
      :  :  N4(ML)=N42(M)
      :  :  DO (M1=1,ND)
      :  :  :  E(M1,ML)=C(M1,M)
      :  :  :  DO (M2=1,ND)
      :  :  :  :  F(M1,M2,ML)=D(M1,M2,M)
      :  :  :  :..FIN
      :  :  :..FIN
      :  :..FIN
      :..FIN
      IF(ISW.EQ.1)ML=NUM1
      NP=100
      WRITE BINARY(4)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      DO (I=1,ML)
      :  WRITE BINARY(4)N1(I),N2(I),N3(I),N4(I)
      :  DO (I1=1,ND)
      :  :  SM(I1)=E(I1,I)
      :  :  DO (I2=1,ND)
      :  :  :  COV(I1,I2)=F(I1,I2,I)
      :  :  :..FIN
      :  :..FIN
      :  WRITE BINARY(4)NP,SM,COV
      :  WRITE(IP,104)N1(I),N2(I),N3(I),N4(I)
      :  WRITE(IP)NP,SM,COV
      :..FIN
100   FORMAT(2A2)
101   FORMAT(2X,"INPUT NA1,NA2")
102   FORMAT(2X,"INPUT TAPE,DATE IN 2I6 FORMAT")
103   FORMAT(2X,"INPUT # OF FILES")
104   FORMAT(6A2)
105   FORMAT(//2X,"ABOVE ARE SIGNATURES FROM FILE1")
106   FORMAT(//2X,"ABOVE ARE SIGNATURES FROM FILE2")
      STOP
      END
```

```
C***********************************************************************
C                                                                      *
C         COPY5                                                        *
C                                                                      *
C         THIS ROUTINE ADDS 5 SIGNATURE , VERTICES , OR HIST           *
C         FILES AND PUTS THEM IN A COPYFILE                            *
C                                                                      *
C         SEQUENCE:  COPY5 OUT IN1 IN2 IN3 IN4 IN5                     *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT GEORGIA TECH EES                                   *
C                                                                      *
C        PROGRAMMER:  NICKOLAS L. FAUST                                *
C                                                                      *
C***********************************************************************
      DIMENSION IOUT(20),IN1(20),IN2(20),IN3(20),IN4(20),IN5(20)
      DIMENSION ICOUNT(4,100),I(6),SM(4),COV(4,4),IVX(101)
      DIMENSION IVY(101),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IOUT,ISW,IERR)
      CALL COMARG(1,IOUT,ISW,IERR)
      CALL COMARG(1,IN1,ISW,IERR)
      CALL COMARG(1,IN2,ISW,IERR)
      CALL COMARG(1,IN3,ISW,IERR)
      CALL COMARG(1,IN4,ISW,IERR)
      CALL COMARG(1,IN5,ISW,IERR)
      IPR=10
      WRITE(IPR,401)
      READ(11)ICON
      WRITE(IPR,402)
      READ(11)M
      L=M+2
      CALL FOPEN(2,IOUT,"B")
      CALL FOPEN(3,IN1,"B")
      CALL FOPEN(4,IN2,"B")
      CALL FOPEN(5,IN3,"B")
      CALL FOPEN(6,IN4,"B")
      CALL FOPEN(7,IN5,"B")
      DO (K=3,L)READ BINARY(K)I
      WRITE BINARY(2)I
      TYPE " L = ",L
      DO (KL=3,L)
      :  FOREVER
      :  :  READ BINARY(KL,END=120)NS1,NS2,NS3,NS4
      :  :  WRITE(IPR,403)NS1,NS2,NS3,NS4
      :  :  WRITE BINARY(2)NS1,NS2,NS3,NS4
      :  :  IF(ICON.EQ.1)
      :  :  :  READ BINARY(KL)NP,SM,COV
      :  :  :  TYPE "  NP =  ",NP
      :  :  :  WRITE BINARY(2)NP,SM,COV
      :  :  :..FIN
      :  :  IF(ICON.EQ.2)
      :  :  :  READ BINARY(KL)K,IYMIN,IYMAX
      :  :  :  DO (K1=1,K)READ BINARY(KL)K11,IVX(K1),IVY(K1)
      :  :  :  WRITE BINARY(2)K,IYMIN,IYMAX
      :  :  :  DO (K1=1,K)WRITE BINARY(2)K1,IVX(K1),IVY(K1)
      :  :  :..FIN
      :  :  IF(ICON.EQ.3)
      :  :  :  READ BINARY(KL)ICOUNT
      :  :  :  WRITE BINARY(2)ICOUNT
      :  :  :..FIN
      :  :..FIN
120   :  CONTINUE
      :..FIN
401   FORMAT(2X," INPUT SWITCH - 1 -SIG , 2 - VER , 3 - HIS")
402   FORMAT(2X," INPUT # OF FILES ")
403   FORMAT(2X,4A2)
      STOP
      END
```

```
C*************************************************************************:
C                                                                         :
C        COUNTY                                                           :
C                                                                         :
C        DRAWS A POLYGON WHEN GIVEN A STRING OF COORDINATES.              :
C                                                                         :
C*************************************************************************:
C                                                                         :
C        CREATED AT GEORGIA TECH EES                                      :
C                                                                         :
C        PROGRAMMER:  MICHAEL D. FURMAN                                   :
C                                                                         >
C*************************************************************************:
      INTEGER IC(2,256),IXY(2,2)
      ACCEPT "# OF POINTS, STRING OF POINTS ",NP,((IC(I,J),I=1,2),J=1,NP)
      DO (I=1,2)
      :  DO (J=1,2) IXY(I,J)=IC(I,1)
      :..FIN
      DO (J=1,NP)
      :  DO (K=1,2)
      :  :  IF ((IC(K,J).LT.IXY(K,1)).AND.(IC(K,J).GE.0)) IXY(K,1)=IC(K,J
      :  :  IF (IC(K,J).GT.IXY(K,2)) IXY(K,2)=IC(K,J)
      :  :..FIN
      :..FIN
      FAX=(IXY(1,2)-IXY(1,1))/511.0
      FAY=(IXY(2,2)-IXY(2,1))/511.0
      WHEN (FAX.GT.FAY) FACT=FAX
      ELSE FACT=FAY
      DO (I=1,NP)
      :  DO (J=1,2) IC(J,I)=(IC(J,I)-IXY(J,1))/FACT
      :..FIN
      NP1=NP-1
      DO (I=1,NP1) CALL VECTOR(0,IC(1,I),IC(2,I),IC(1,I+1),IC(2,I+1),0,20
      CALL VECTOR(0,IC(1,I),IC(2,I),IC(1,1),IC(2,1),0,200)
      STOP
      END
```

```
C***********************************************************************
C                                                                      *
C       CRDEM4                                                         *
C                                                                      *
C       CREATE DEMO FROM DISPLAY IMAGE INCLUDING                       *
C       FUNCTION MEMORY, COLOR MEMORY, AND GRAPHICS                    *
C                                                                      *
C       SEQUENCE: CRDEM4 MTU:F                                         *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT GEORGIA TECH EES                                    *
C                                                                      *
C       PROGRAMER:  FRED L. THOMPSON                                   *
C                                                                      *
C***********************************************************************
      INTEGER ISW(2),INPUT(512),IARAY(64),IBRAY(0:255),IFLD(10)
      CALL OPEN (1,"COM.CM",1,IE)
      CALL COMARG (1,IFLD,ISW,IE)
      CALL COMARG (1,IFLD,ISW,IE)
      CALL MTOPD (3,IFLD,0,IE)
      DO (I=1,512) INPUT(I)=0
      CALL RCM (0,INPUT(3))
      ACCEPT "512 OR 256 ",ISZ
      ACCEPT "TYPE 1 TO RECORD GRAPHICS",IANS
      TYPE "TYPE A THIRTY CHARACTER DESCRIPTION "
      TYPE "..............................."
      READ (11,100) (INPUT(I),I=68,98)
  100 FORMAT (30A1)
      INPUT(1)=ISZ
      INPUT(2)=IANS
      CALL MTDIO (3,50000K+ISZ,INPUT,IST,IE,ICNT)
      DO (I=0,2)
      :  CALL RFUM (I,INPUT)
      :  CALL MTDIO (3,50000K+ISZ,INPUT,IST,IE,ICNT)
      :..FIN
      IEND=ISZ-1
      ISZ1=ISZ/2
      DO (IY=0,IEND)
      :  CALL IMRD (0,IY,INPUT,ISZ1)
      :  CALL MTDIO (3,50000K+ISZ,INPUT,IST,IE,ICNT)
      :  IF (ISZ.EQ.256)
      :  :  DO (I=1,2)
      :  :  :  CALL IMRD (I,IY,INPUT,ISZ1)
      :  :  :  CALL MTDIO (3,50000K+ISZ,INPUT,IST,IE,ICNT)
      :  :  :..FIN
      :  :  IF (IANS.EQ.1)
      :  :  :  DO (I=0,3)
      :  :  :  :  CALL GRD (I,IY,INPUT,16)
      :  :  :  :  CALL MTDIO (3,50000K+ISZ,INPUT,IST,IE,ICNT)
      :  :  :  :..FIN
      :  :  :..FIN
      :  :..FIN
      :..FIN
      DO (I=1,2) CALL MTDIO (3,60000K,INPUT,IST,IE,ICNT)
      STOP
      END
```

```
C***************************************************************************
C
C         CYTAPE
C
C         MAKES FILE INTO A CYBER 74 COMPATABLE FORMAT
C
C         SEQUENCE:  CYTAPE FILE FILE
C
C***************************************************************************
C
C         CREATED AT GEORGIA TECH EES
C
C         PROGRAMMER:  MICHAEL D. FURMAN
C
C***************************************************************************
      DIMENSION S(30),IFILE(10),NS(4),IFILE2(10),ITAP(3),IDAT(3),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IFILE,ISW,IERR)
      CALL COMARG(1,IFILE,ISW,IERR)
      CALL COMARG(1,IFILE2,ISW,IERR)
      CALL FOPEN(2,IFILE,"B")
      CALL FOPEN(3,IFILE2,"B")
      READ BINARY(2,END=205) ITAP,IDAT
      FOREVER
      :  DO (I=1,30) S(I)=0.
      :  READ BINARY(2,END=205)NS
      :  READ BINARY(2,END=205) NP,(S(I),I=1,20)
      :  WRITE BINARY(3) NS
      :  WRITE(3)
      :  WRITE(3,100) NP,(S(I),I=1,20)
      :..FIN
      STOP
  205 STOP FINISHED
  100 FORMAT(1X,I4,5(4F12.8,/))
      END
```

```
C***********************************************************************
C                                                                      *
C        DISDEM4                                                       *
C                                                                      *
C        DISPLAYS DEMO TAPES TO COMTAL COLOR DISPLAY                   *
C        WITH GRAPHICS COLOR MEMORY AND FUNCTION MEMORY                *
C                                                                      *
C        SEQUENCE:   DISDEM4 MTU:F                                     *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT GEORGIA TECH EES                                   *
C                                                                      *
C        PROGRAMMER:   FRED L. THOMPSON                                *
C                                                                      *
C***********************************************************************
      INTEGER ISW(2),INPUT(512),IFLD(10)
      CALL OPEN (1,"COM.CM",1,IE)
      CALL COMARG (1,IFLD,ISW,IE)
      CALL COMARG (1,IFLD,ISW,IE)
      CALL MTOPD (3,IFLD,0,IE)
      FOREVER
      :  CALL MTDIO (3,0,INPUT,IST,IE,ICNT)
      :  ISZ=INPUT(1)
      :  IANS=INPUT(2)
      :  WRITE (10,100) (INPUT(I),I=68,98)
100   :  FORMAT (1X,30A1)
      :  IF (ISZ.EQ.512) PAUSE SET BIC FOR 512 HIT RETURN
      :  IF (ISZ.EQ.256) PAUSE SET BIC FOR 256 HIT RETURN
      :  CALL WCM (0,INPUT(3))
      :  DO (I=0,2)
      :  :  CALL MTDIO (3,0,INPUT,IST,IE,ICNT)
      :  :  CALL WFUM (I,INPUT)
      :  :..FIN
      :  IEND=ISZ-1
      :  ISZ1=ISZ/2
      :  DO (IY=0,IEND)
      :  :  CALL MTDIO (3,0,INPUT,IST,IE,ICNT)
      :  :  CALL IMWR (0,IY,INPUT,ISZ1)
      :  :  IF (ISZ.EQ.256)
      :  :  :  DO (I=1,2)
      :  :  :  :  CALL MTDIO (3,0,INPUT,IST,IE,ICNT)
      :  :  :  :  CALL IMWR (I,IY,INPUT,ISZ1)
      :  :  :  :..FIN
      :  :  :  IF (IANS.EQ.1)
      :  :  :  :  DO (I=0,3)
      :  :  :  :  :  CALL MTDIO (3,0,INPUT,IST,IE,ICNT)
      :  :  :  :  :  CALL GWR (I,IY,INPUT,16)
      :  :  :  :  :..FIN
      :  :  :  :..FIN
      :  :  :..FIN
      :  :..FIN
      :  CALL MTDIO (3,0,INPUT,IST,IE,ICNT)
      :  PAUSE HIT RETURN FOR NEXT FILE CTRL A TO END
      :..FIN
      STOP
      END
```

```
C***************************************************************************
C
C        DRAWER
C
C        USED WITH ELIP TO DRAW 2-D ELLIPSES OF SIGNATURES
C        ON THE VERSATEC
C
C***************************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:   G. DAVID GENTRY
C
C***************************************************************************
      SUBROUTINE DRAWER(SM,E,COV,AX1,AX2,R,ID)
      DIMENSION R(2,2),SM(2),E(2,4),COV(2,2)
      IF(ID.GE.1)GO TO 9
      CALL DRAW(.5,.5,1,1001)
      CALL MODE(7,8.,8.,9999.)
      CALL MODE(8,180.,10.,0.)
      CALL MODE(9,180.,10.,0.)
      CALL AXES(7.0,"CHANNEL",7.0,"CHANNEL")
      CALL NOTE(-.5,5.,AX2,1000)
      CALL NOTE(5.,-.5,AX1,1000)
9     IO=10
      IF(ID.EQ.0)IDC=43
      IF(ID.EQ.1)IDC=31
      IF(ID.EQ.2)IDC=42
      THETA=ATAN2(R(2,1),R(1,1))
      IF(COV(1,2) .LT. 0.)THETA=ATAN2(R(2,2),R(1,2))
      IF(COV(1,2) .LT. 0.)WRITE(IO,12)
12    FORMAT(//" COV(X,Y) IS NEGATIVE")
      THET=57.29578*THETA
      WRITE(IO,11)THET
11    FORMAT(//" THE ROTATION ANGLE IS",F6.2," DEGREES"//)
      DO (I=1800,2600,10)
      :   J=((I-1800)/10)+1
      :   X1=FLOAT(I)/10.
      :   X=X1-SM(1)
      :   IF(COV(1,2) .LT. 0.)GO TO 6
      :   A=E(2,1)*(SIN(THETA))**2+E(1,1)*(COS(THETA))**2
      :   B=2.*X*(E(2,1)*(SIN(THETA))*(COS(THETA))-E(1,1)*(SIN(THETA))
     1:   *(COS(THETA)))
      :   C=X**2*(E(2,1)*(COS(THETA))**2+E(1,1)*(SIN(THETA))**2)
     1:   -3.*E(1,1)*E(2,1)
      :   IF(B**2-4.*A*C)5,7,7
6     :   A=E(1,1)*(SIN(THETA))**2+E(2,1)*(COS(THETA))**2
      :   B=2.*X*(E(1,1)*(SIN(THETA))*(COS(THETA))-E(2,1)*(SIN(THETA))
     1:   *(COS(THETA)))
      :   C=X**2*(E(1,1)*(COS(THETA))**2+E(2,1)*(SIN(THETA))**2)
     1:   -3.*E(1,1)*E(2,1)
      :   IF(B**2-4.*A*C)5,7,7
7     :   Y1=SM(2)+(-B+SQRT(B**2-4.*A*C))/(2.*A)
      :   Y2=SM(2)+(-B-SQRT(B**2-4.*A*C))/(2.*A)
      :   CALL NOTE(X1,Y1,IDC,-1)
      :   CALL NOTE(X1,Y2,IDC,-1)
5     :   CONTINUE
      :..FIN
      SPLOT1=SM(1)
      SPLOT2=SM(2)
      CALL NOTE(SPLOT1,SPLOT2,IDC,-1)
      RETURN
      END
```

```
C*************************************************************************
C                                                                        *
C        DTAPE                                                           *
C                                                                        *
C        GENERAL TAPE DUMPING ROUTINE FOR READING AND                    *
C        DEBUGGING FOREIGN TAPES                                         *
C                                                                        *
C        SEQUENCE:   DTAPE MTU:F                                         *
C                                                                        *
C*************************************************************************
C                                                                        *
C        CREATED AT GEORGIA TECH EES                                     *
C                                                                        *
C        PROGRAMMER:   MICHAEL D. FURMAN                                 *
C                                                                        *
C*************************************************************************
      INTEGER IDATA(4110),IOUT(8220),IFLD(10),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IFLD,ISW,IERR)
      CALL COMARG(1,IFLD,ISW,IERR)
 100  FORMAT(1X,20I6)
 101  FORMAT(1X,25I4)
 102  FORMAT(1X,100A1)
 103  FORMAT(1X,10(O18,1HK))
 104  FORMAT(1X,20(O15,1HK))
      ACCEPT "WORDS? (1), OR BYTES? (0) OUTPUT ",IP
      ACCEPT "BASE: TEN= 1 , EIGHT= 0  ",IN
      ACCEPT "SKIP HOW MANY RECORDS? ",ISKP
      ACCEPT "DUMP HOW MANY BLOCKS OF DATA ",IBLOK
      IF ((IP.EQ.0).AND.(IN.EQ.1))
      :  TYPE "TYPE: NUMERIC= 0 ; ASCII= 1 ; EBCDIC= 2 "
      :  READ(11) IQ
      :..FIN
      CALL MTOPD(3,IFLD,0,IERR)
      IF (ISKP.GT.0)
      :  DO (I=1,ISKP) CALL MTDIO(3,0,IDATA,IS,IE,IC)
      :..FIN
      DO (K1=1,IBLOK)
      :  DO (I=1,4110)  IDATA(I)=0
      :  DO (I=1,8220)  IOUT(I)=0
      :  CALL MTDIO(3,0,IDATA,IS,IE,IC)
      :  TYPE "RECORDS PER BLOCK= ",IC
      :  IF (IP.EQ.0)
      :  :  CALL UPAC8(IDATA,IOUT,IC)
      :  :  IF (IQ.EQ.2) CALL EBCDIC(IOUT,IOUT,ID)
      :  :  IC=IC*2
      :  :..FIN
      :  WHEN (IQ.NE.0) WRITE(12,102)(IOUT(I),I=1,IC)
      :  ELSE
      :  :  IF ((IN.EQ.1).AND.(IP.EQ.1)) WRITE(12,100)(IDATA(I),I=1,IC)
      :  :  IF ((IP.EQ.1).AND.(IN.EQ.0)) WRITE(12,103)(IDATA(I),I=1,IC)
      :  :  IF ((IP.EQ.0).AND.(IN.EQ.1)) WRITE(12,101)(IOUT(I),I=1,IC)
      :  :  IF ((IP.EQ.0).AND.(IN.EQ.0)) WRITE(12,104)(IOUT(I),I=1,IC)
      :  :..FIN
      :  WRITE(12)
      :..FIN
      STOP
      END
```

```
C*****************************************************************************:
C                                                                             :
C        EBCDIC   (SUBROUTINE)                                                :
C                                                                             :
C        CONVERTS EBCDIC CODE INTO ASCII                                      :
C                                                                             :
C        SEQUENCE:  EBCDIC( INPUT ARRAY, OUTPUT ARRAY, ARRAY DIMENSIONS)      :
C                                                                             :
C*****************************************************************************:
C                                                                             :
C        CREATED AT GEORGIA TECH EES                                          :
C                                                                             :
C        PROGRAMMER:  MICHAEL D. FURMAN                                       :
C                                                                             :
C*****************************************************************************:
      SUBROUTINE EBCDIC( INPUT, IOUT, IPR)
       INTEGER INPUT( IPR) , IOUT( IPR)
      COMMON/DUM1/ICNTAB(263)
       DATA ICNTAB/1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     11H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     11H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     11H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     21H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H ,1H?,1H?,
     21H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H.,1H?,1H(,1H+,1H?,1H?,
     21H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H$,1H*,1H),1H?,
     31H?,1H-,1H/,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H,,1H?,
     31H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     31H?,1H?,1H',1H=,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     41H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     41H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     41H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     51H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,1H?,
     51HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1H?,1H?,1H?,1H?,1H?,
     51H?,1H?,1HJ,1HK,1HL,1HM,1HN,1HO,1HP,1HQ,1HR,1H?,1H?,1H?,
     61H?,1H?,1H?,1H?,1H?,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ,1H?,
     61H?,1H?,1H?,1H?,1H?,1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,
     61H9,1H?,1H?,1H?,1H?,1H?/
C
      DO ( I=1, IPR)
      :   K1=INPUT( I)+1
      :   WHEN (K1.LE.256)
      :   :   IOUT( I)=ICNTAB(K1)
      :   :..FIN
      :   ELSE IOUT( I)=ICNTAB( 1)
      :..FIN
      END
```

```
C***********************************************************************
C                                                                      *
C       EDIST   (SUBROUTINE)                                           *
C                                                                      *
C       PURPOSE:                                                       *
C       COMPUTES THE DISTANCE BETWEEN TWO VECTORS                      *
C                                                                      *
C       DESCRIPTION OF PARAMETERS                                      *
C                                                                      *
C       CALLING SEQUENCE                                               *
C       INPUT                                                          *
C       V1,V2 - TWO VECTORS                                            *
C       ND - DIMENSION OF THE VECTORS                                  *
C                                                                      *
C       OUTPUT                                                         *
C       CALLING SEQUENCE                                               *
C       D  - CONTAINS DISTANCE BETWEEN V1 AND V2                       *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT NASA/JSC   (ASTEP)                                  *
C                                                                      *
C***********************************************************************
      SUBROUTINE EDIST ( V1, V2, ND, D )
      DIMENSION V1(ND),V2(ND)
      D = 0.
      DO 10 I=1,ND
   10 D = D + (V1(I)-V2(I))**2
      D = SQRT(D)
      RETURN
      END
```

```
C***********************************************************************
C                                                                      :
C        EIGEN   (SUBROUTINE)                                          :
C                                                                      :
C        COMPUTES EIGENVALUES AND EIGENVECTORS OF REAL                 :
C        SYMMETRICAL MATRIX                                            :
C                                                                      :
C***********************************************************************
C                                                                      :
C        CREATED AT NASA/JSC   (ASTEP)                                 :
C                                                                      :
C***********************************************************************
      SUBROUTINE EIGEN(AA,N,MV,A,E,R)
      DIMENSION AA(N,N),R(N,N),E(N),A(N,N)
202   FORMAT(//" SUBROUTINE EIGEN ERROR RETURN-FINAL NORM HAS NOT
     1BEEN REACHED AFTER 100 ITERATIONS"/)
      DO (I=1,N)
      :  DO (J=1,N)
      :  :  A(I,J)=AA(I,J)
      :  :..FIN
      :..FIN
      RANGE=1.E-6
      IF(MV-1)10,25,10
10    DO (I=1,N)
      :  DO (J=1,N)
      :  :  IF(I .EQ. J)GO TO 15
      :  :  R(I,J)=0.
      :  :  GO TO 20
15    :  :  R(I,J)=1.
20    :  :  CONTINUE
      :  :..FIN
      :..FIN
25    ANORM=0.
      DO (I=1,N)
      :  DO (J=1,N)
      :  :  IF(I .EQ. J) GO TO 35
      :  :  ANORM=ANORM+A(I,J)*A(I,J)
35    :  :  CONTINUE
      :  :..FIN
      :..FIN
      IF(ANORM)165,165,40
40    ANORM=SQRT(ANORM)
      ANRMX=ANORM*RANGE
      ICNT=0
      IND=0
      THR=ANORM
45    THR=THR/FLOAT(N)
      ICNT=ICNT+1
      IF(ICNT .EQ. 100) GO TO 200
50    MQ=2
55    MP=1
      X=.5*(A(MP,MP)-A(MQ,MQ))
62    IF(ABS(A(MP,MQ))-THR)138,65,65
65    IND=1
      X=.5*(A(MP,MP)-A(MQ,MQ))
      Y=-A(MP,MQ)/SQRT(A(MP,MQ)*A(MP,MQ)+X*X)
```

```
      IF(X)70,75,75
70    Y=-Y
75    SINX=Y/SQRT(2.*(1.+(SQRT(1.-Y*Y))))
      SINX2=SINX*SINX
      COSX=SQRT(1.-SINX2)
      COSX2=COSX*COSX
      SINCS=SINX*COSX
      XX=A(MP,MP)
      YY=A(MQ,MQ)
      ZZ=A(MP,MQ)
      DO (I=1,N)
      :   X=A(I,MP)*COSX-A(I,MQ)*SINX
      :   A(I,MQ)=A(I,MP)*SINX+A(I,MQ)*COSX
      :   A(I,MP)=X
      :   IF(MV-1)120,125,120
120   :   X=R(I,MP)*COSX-R(I,MQ)*SINX
      :   R(I,MQ)=R(I,MP)*SINX+R(I,MQ)*COSX
      :   R(I,MP)=X
125   :   CONTINUE
      :..FIN
      X=2.*ZZ*SINCS
      Y=(XX*COSX2)+(YY*SINX2)-X
      X=(XX*SINX2)+(YY*COSX2)+X
      A(MP,MP)=Y
      A(MQ,MQ)=X
      A(MP,MQ)=(XX-YY)*SINCS+ZZ*(COSX2-SINX2)
      A(MQ,MP)=0.
      DO (I=1,N)
      :   A(MP,I)=A(I,MP)
      :   A(MQ,I)=A(I,MQ)
      :..FIN
138   IF(MP .NE. (MQ-1))GO TO 140
      IF(MQ .NE. N) GO TO 145
      IF(IND .NE. 1)GO TO 160
      IND=0
      GO TO 50
140   MP=MP+1
      GO TO 62
145   MQ=MQ+1
      GO TO 55
160   IF(THR - ANRMX)165,165,45
165   CONTINUE
      DO (I=1,N)
      :   DO (J=1,N)
      :   :   IF(I .NE. J) GO TO 190
      :   :   E(I)=A(I,J)
190   :   :   CONTINUE
      :   :..FIN
      :..FIN
      GO TO 210
200   WRITE(10,202)
210   RETURN
      END
```

```
C*************************************************************************
C
C        ELIP
C
C        DRAWS 2-D ELLIPSES OF COVARIANCE MATRICIES
C
C        SEQUENCE:  ELIP REQFIL SIGFILC
C
C*************************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:  G. DAVID GENTRY
C
C*************************************************************************
      DIMENSION REQ(30),SIGFIL(30),E(2,4),R(2,2),D(2,2),IORDER(20)
      DIMENSION COVIN(4,4,20),SMIN(4,20),N1(20),N2(20),N3(20),N4(20)
      DIMENSION COV1(2,2),SM1(2),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,REQ,ISW,IERR)
      CALL COMARG(1,REQ,ISW,IERR)
      CALL COMARG(1,SIGFIL,ISW,IERR)
      CALL FOPEN(2,REQ,"B")
      IO=10
      ACCEPT "INPUT NUMBER OF ELIPSES PER PLOT  ",NUMS
      IIN=11
      ND=2
      NSIG=20
      CALL MODE(1,1.,.5,-1.)
      MSIG=NSIG/NUMS
      DO(JV=1,MSIG)
      :  NSIG=NUMS
      :  KO=0
      :  CALL GSIG(SMIN,COVIN,NSIG,2,3,SIGFIL,IORDER,N1,N2,N3,N4)
      :  DO (JJ=1,3)
      :  :  K=JJ+1
      :  :  DO (KK=K,4)
      :  :  :  AX1=JJ
      :  :  :  AX2=KK
      :  :  :  ID=0
      :  :  :  DO (II=1,NSIG)
      :  :  :  :  SM1(1)=255.-SMIN(JJ,II)
      :  :  :  :  SM1(2)=255.-SMIN(KK,II)
      :  :  :  :  COV1(1,1)=COVIN(JJ,JJ,II)
      :  :  :  :  COV1(1,2)=COVIN(JJ,KK,II)
      :  :  :  :  COV1(2,1)=COVIN(KK,JJ,II)
      :  :  :  :  COV1(2,2)=COVIN(KK,KK,II)
      :  :  :  :  CALL FACANL(COV1,SM1,ND,E,R,D)
      :  :  :  :  CALL DRAWER(SM1,E,COV1,AX1,AX2,R,ID)
      :  :  :  :  ID=ID+1
      :  :  :  :..FIN
      :  :  :  KO=KO+1
      :  :  :  IF(KO.EQ.1)
      :  :  :  :  CALL DRAW(0.,0.,1,0000)
      :  :  :  :  CALL DRAW(-.5,8.5,1,1001)
      :  :  :  :..FIN
      :  :  :  IF(KO.EQ.2)
      :  :  :  :  KO=0
      :  :  :  :  CALL DRAW(0.,0.,1,0000)
      :  :  :  :  CALL DRAW(0.,-9.5,1,1001)
      :  :  :  :  CALL DRAW(0.,0.,1,9000)
      :  :  :  :..FIN
      :  :  :..FIN
      :  :..FIN
      :..FIN
      CALL DRAW(0,0,0,9999)
      STOP
      END
```

```
C***************************************************************************
C                                                                          *
C        FACANL  (SUBROUTINE)                                              *
C                                                                          *
C        USED WITH ELIP TO DO FACTOR ANALYSIS OF COV. MATRIX               *
C                                                                          *
C***************************************************************************
C                                                                          *
C        CREATED BY NASA JSC                                               *
C                                                                          *
C***************************************************************************
      SUBROUTINE FACANL(COV,SM,ND,E,R,D)
      DIMENSION COV(ND,ND),SM(ND),E(ND,4),R(ND,ND),D(ND,ND)
      MV=0
      CALL EIGEN(COV,ND,MV,D,E,R)
      ND1=ND-1
      IF(ND1 .EQ. 0)RETURN
      DO (J=1,ND1)
      :  EMAX=0.
      :  DO (I=J,ND)
      :  :  IF(E(I,1) .LT. EMAX) GO TO 50
      :  :  EMAX=E(I,1)
      :  :  IS=I
50    :  :  CONTINUE
      :  :..FIN
      :  DUM=E(J,1)
      :  E(J,1)=E(IS,1)
      :  E(IS,1)=DUM
      :  DO (I=1,ND)
      :  :  DUM=R(I,J)
      :  :  R(I,J)=R(I,IS)
      :  :  R(I,IS)=DUM
      :  :..FIN
      :..FIN
      DUM=0.
      DO (I=1,ND)
      :  DUM=DUM+E(I,1)
      :..FIN
      DUM=1./DUM
      EMAX=0.
      DO (I=1,ND)
      :  E(I,2)=DUM*E(I,1)
      :  E(I,3)=EMAX+E(I,2)
      :  EMAX=E(I,3)
      :..FIN
      DUM=0.
      DO (I=1,ND)
      :  DUM=DUM+SM(I)**2
      :..FIN
      DUM=SQRT(DUM)
      DO (J=1,ND)
      :  E(J,4)=0.
      :  DO (I=1,ND)
      :  :  E(J,4)=E(J,4)+SM(I)*R(I,J)
      :  :..FIN
      :  E(J,4)=E(J,4)/DUM
      :  E(J,4)=57.29578*ACOS(E(J,4))
      :..FIN
      RETURN
      END
```

```
C***********************************************************************
C
C        FILTER1
C
C        PERFORMS A HIGH-PASS FILTER ON DISPLAY
C
C***********************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:   MICHAEL D. FURMAN
C
C***********************************************************************
      INTEGER IN(512,3),IMAG1(256),IMAG2(512),IMAG3(256)
      INTEGER IN2(512,3),IN3(512,3)
      ACCEPT "512 OR 256 MODE ",IMODE
      IMOM1=IMODE-1
      IMOM2=IMODE-2
      IANS=0
      IF (IMODE.EQ.256)
      :  ACCEPT "ALL 3 IMAGES AT ONCE? (1=YES) ",IANS
      :  IF (IANS.NE.1) ACCEPT "IMAGE NUMBER(0-2) ",IM2
      :..FIN
      DO (IM=0,2)
      :  IF ((IANS.NE.1).AND.(IMODE.NE.512)) IM=IM2
      :  M3=2
      :  M4=3
      :  DO (I=0,1)
      :  :  CALL IMREAD(IM,I,IMAG1,256)
      :  :  CALL UPAC8(IMAG1,IN(1,(I+1)),256)
      :  :..FIN
      :  DO (M5=2,IMOM2)
      :  :  M5M1=M5-1
      :  :  CALL IMREAD(IM,M5,IMAG1,256)
      :  :  CALL UPAC8(IMAG1,IN(1,M4),256)
      :  :  DO (I=1,MODE) IMAG2(I)=0
      :  :  DO (J1=1,3)
      :  :  :  DO (K=2,IMOM1) IMAG2(K)=IMAG2(K)+IN(K-1,J1)+IN(K,J1)+IN(K+
      :  :  :..FIN
      :  :  DO (I=1,IMODE)
      :  :  :  IMAG2(I)=(IN(I,M3)*2)-((IMAG2(I)/9.0)+0.5)
      :  :  :  IF (IMAG2(I).LT.0) IMAG2(I)=0
      :  :  :  IF (IMAG2(I).GT.255) IMAG2(I)=255
      :  :  :..FIN
      :  :  CALL PAC8(IMAG2,IMAG3,512)
      :  :  CALL IMWRITE(IM,M5M1,IMAG3,256)
      :  :  WHEN (M4.EQ.3) M4=1
      :  :  ELSE M4=M4+1
      :  :  WHEN (M3.EQ.3) M3=1
      :  :  ELSE M3=M3+1
      :  :..FIN
      :  IF ((IANS.NE.1).OR.(IMODE.EQ.512)) STOP
      :..FIN
      CALL BACK
      END
```

```
C***************************************************************************
C                                                                          *
C       GETPOLY                                                            *
C                                                                          *
C       THIS PROGRAM SUMS AREAS OF ALL MAXIMUM LIKLIHOOD CLASS             *
C       WITHIN A SPECIFIED POLYGON                                         *
C       POLYGON DATA IS THEN DUMPED TO TAPE                                *
C                                                                          *
C       SEQUENCE: GETPOLY INPUT MTU:F MTU:F                                *
C                                                                          *
C***************************************************************************
C                                                                          *
C       CREATED AT GEORGIA TECH EES                                        *
C                                                                          *
C       PROGRAMMER:  NICKOLAS L. FAUST                                     *
C                                                                          *
C***************************************************************************
      DIMENSION COUNT(60),JBUF(3300),IVX(201),IVY(201)
      DIMENSION LA(233),KBUF(3300)
      DIMENSION IFIL(20),ITAP(20),JTAP(20),ISW(2)
      IIN=11
      IIO=10
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,ITAP,ISW,IERR)
      CALL COMARG(1,JTAP,ISW,IERR)
      CALL FOPEN(IIN,IFIL,"B")
      CALL MTOPD(3,ITAP,0,IE)
      CALL MTOPD(4,JTAP,0,IE)
      WRITE(IIO,400)
      DO (I=1,3300)KBUF(I)=0
      DO (I=1,133)LA(I)=0
400   FORMAT(2X,"INPUT 1 FOR OUTPUT OF POLYGON TO TAPE")
      DO (I=1.60) COUNT(I)=0.0
      READ(IIN)IOUT
      WRITE(IIO)IOUT
      ICUT=10000
      WRITE(IIO,401)
401   FORMAT(2X,"INPUT 1 TO USE A THRESHOLD")
      READ(IIN)IZ
      WRITE(IIO)IZ
      IF(IZ.EQ.1)
      :  WRITE(IIO,402)
402   :  FORMAT(2X,"INPUT THRESHOLD ")
      :  READ(IIN)ICUT
      :  WRITE(IIO)ICUT
      :..FIN
      ACCEPT "  START LINE OF CLASSIFIED DATA ?  ",ISTART
      IYMIN=10000
      IXMIN=10000
      IYMAX=0
      READ(IIN) NV
      WRITE(IIO)NV
201   FORMAT(2I2)
      DO (I=1,NV)
      :  READ(IIN,206) IVX(I),IVY(I)
      :  IVY(I)=IVY(I)-ISTART+1
      :  IF(IVY(I).LT.1)IVY(I)=1
      :  IF(IVX(I).LT.1)IVX(I)=1
      :  WRITE(IIO)IVX(I),IVY(I)
      :  IF(IVY(I).LT.IYMIN)IYMIN=IVY(I)
      :  IF(IVX(I).LT.IXMIN) IXMIN=IVX(I)
      :  IF(IVY(I).GT.IYMAX) IYMAX=IVY(I)
      :..FIN
```

```
      IVX(NV+1)=IVX(1)
      IVY(NV+1)=IVY(1)
      IDEL=IYMAX-IYMIN+1
      WRITE(IIO)IDEL
      IF(IOUT.EQ.1)
      :   JBUF(1)=IDEL
      :   CALL MTDIO(4,50000K+3300,JBUF,IS,IE)
      :..FIN
      ISKIP=(IYMIN-1)*2+1
      IF(ISKIP.GT.0)
 206  :   FORMAT(2I4)
      :   DO (K=1,ISKIP)
      :   :   CALL MTDIO(3,0,JBUF,IS,IE)
      :   :..FIN
      :..FIN
      ISK=IYMIN-1
      DO (J=1,IDEL)
      :   DO (I=1,3300)JBUF(I)=60
      :   DO (I=1,3300)KBUF(I)=10000
      :   CALL MTDIO(3,0,JBUF,IS,IE)
      :   CALL MTDIO(3,0,KBUF,IS,IE)
      :   ISW=2
      :   CALL POLY2(IYMIN+J-1,ISW,IVX,IVY,NV,LA)
      :   NSTR=LA(1)
      :   JV=1
      :   WRITE(10)NSTR
      :   DO (NSEQ=1,NSTR)
      :   :   LSUB=2*NSEQ
      :   :   L2=LSUB+1
      :   :   JS=LA(LSUB)
      :   :   IF(JS.LT.1)JS=1
      :   :   JF=LA(L2)
      :   :   WRITE(IIO,28)JS,JF,JV
 28   :   :   FORMAT(2X,"JS,JF,JV   ",3I10)
      :   :   JS1=JS-1
      :   :   IF(JS1.NE.0)
      :   :   :   DO (K2=JV,JS1)JBUF(K2)=60
      :   :   :   DO (K3=JV,JS1)KBUF(K3)=10000
      :   :   :..FIN
      :   :   JV=JF+1
      :   :   DO (J1=JS,JF)
      :   :   :   IF(KBUF(J1).GT.ICUT)JBUF(J1)=60
      :   :   :   LS1=JBUF(J1)
      :   :   :   IF(LS1.GT.60)LS1=60
      :   :   :   COUNT(LS1)=COUNT(LS1)+1.
      :   :   :..FIN
      :   :..FIN
      :   JF1=JF+1
      :   DO (J1=JF1,3300)JBUF(J1)=60
      :   DO (J1=JF1,3300)KBUF(J1)=10000
      :   IF(IOUT.EQ.1)
      :   :   CALL MTDIO(4,50000K+3300,JBUF,IS,IE)
      :   :   CALL MTDIO(4,50000K+3300,KBUF,IS,IE)
      :   :   WRITE(10,211)J
 211  :   :   FORMAT(2X,"LINE #   ",I5,"   PROCESSED")
      :   :..FIN
      :..FIN
      DO (K=1,60)
      :   ACRE=COUNT(K)*1.05
      :   WRITE(IIO,100) K,COUNT(K),ACRE
 100  :   FORMAT(2X,"CLASS # ",I10," SIZE ",F11.0," ACRES ",F11.0)
      :..FIN
      CALL MTDIO(4,60000K,JBUF,IS,IE)
      CALL MTDIO(4,60000K,JBUF,IS,IE)
      STOP
      END
```

```
C*****************************************************************************
C                                                                            *
C        GSIG  (SUBROUTINE)                                                  *
C                                                                            *
C        GETS CLASSIFICATION SIGNATURES                                      *
C        NUN1 IS INPUT FILE (NAMES OF SIGNATURES TO BE RETRIEVED)            *
C        NUN2 IS SIGFILE FROM WHICH SIGNATURES WILL BE TAKEN                 *
C                                                                            *
C*****************************************************************************
C                                                                            *
C        CREATED AT GEORGIA TECH EES                                         *
C                                                                            *
C        PROGRAMMER:  NICKOLAS L. FAUST                                      *
C                                                                            *
C*****************************************************************************
      SUBROUTINE GSIG(A,B,NSIG,ITEMSIG,N1,N2,N3,N4,APR)
      DIMENSION A(4,60),B(4,4,60).SM(4),COV(4,4),ITEMSIG(34)
      DIMENSION N1(60),N2(60),N3(60),N4(60),APR(60)
      IP=12
      NUN1=2
      NUN2=4
      DO (I=1,NSIG)
      :  READ(NUN1,100)NA1,NA2,NA3,NA4,APRI
      :  N1(I)=NA1
      :  N2(I)=NA2
      :  N3(I)=NA3
      :  N4(I)=NA4
      :  APR(I)=APRI
      :  CALL FOPEN(NUN2,ITEMSIG,"B")
      :  READ BINARY(NUN2)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      :  ISET=0
      :  WHILE(ISET.EQ.0)
      :  :  READ BINARY(NUN2,END=120)NS1,NS2,NS3,NS4
      :  :  READ BINARY(NUN2)NP,SM,COV
      :  :  IF(NS1.EQ.NA1.AND.NS2.EQ.NA2)
      :  :  :  IF(NS3.EQ.NA3.AND.NS4.EQ.NA4)
      :  :  :  :  DO (K=1,4)
      :  :  :  :  :  A(K,I)=SM(K)
      :  :  :  :  :  DO (L=1,4)
      :  :  :  :  :  :  B(K,L,I)=COV(K,L)
      :  :  :  :  :  :..FIN
      :  :  :  :  :..FIN
      :  :  :  :  ISET=1
      :  :  :  :  CALL FCLOSE(NUN2)
      :  :  :  :..FIN
      :  :  :..FIN
      :  :..FIN
      :..FIN
      RETURN
100   FORMAT(4A2,F10.8)
120   STOP  FILE NOT FOUND
      END
```

```
C***********************************************************************
C
C        HISTO    (SUBROUTINE)
C
C        THIS SUBROUTINE CALCULATES AND DISPLAYS A HISTOGRAM FOR A
C        SPECIFIED DATA SET - 4 CHANNELS = 4 HISTOGRAMS
C
C***********************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:  NICKOLAS L. FAUST
C
C***********************************************************************
      SUBROUTINE HIST(NUM)
      DIMENSION ICOUNT(4,100),MAX(4),MIN(4)
      COMMON/DTRANS/IMODL(256),IX(512,4),IDUM(512)
      COMMON /HISTO/ ICOUNT
      ND=4
      DO (IJ=1,100)
      :  DO (JI=1,ND)
      :  :   ICOUNT(JI,IJ)=0
      :  :..FIN
      :..FIN
      DO (I=1,ND)
      :  DO (K=1,NUM)
      :  :   J=IX(K,I)
      :  :   IF(J.EQ.0)J=99
      :  :   IF(J.GT.99)J=99
      :  :   ICOUNT(I,J)=ICOUNT(I,J)+1
      :  :..FIN
      :..FIN
      DO (KCH=1,ND)
      :  MIN(KCH)=1000
      :  MAX(KCH)=0
      :  DO (KK=1,60)
      :  :   IF(ICOUNT(KCH,KK).LT.MIN(KCH))MIN(KCH)=ICOUNT(KCH,KK)
      :  :   IF(ICOUNT(KCH,KK).GT.MAX(KCH))MAX(KCH)=ICOUNT(KCH,KK)
      :  :..FIN
      :  IF(MAX(KCH).EQ.0)MAX(KCH)=1
      :  DO (JJ=1,60)
      :  :   ICOUNT(KCH,JJ)=(ICOUNT(KCH,JJ)*20)/MAX(KCH)
      :  :..FIN
      :..FIN
      DO (L=1,20)
      :  LI=256-L
      :  DO (K=1,512)  IDUM(K)=0
      :  DO (KCH=1,4)
      :  :   ISUB=(KCH-1)*60+NJ
      :  :   IF(ICOUNT(KCH,NJ).GT.L)IDUM(ISUB)=140
      :  :..FIN
      :..FIN
      IDUM(1)=140
      IDUM(60)=140
      IDUM(120)=140
      IDUM(180)=140
      CALL CPACK1(IDUM,IMODL,0)
      WHEN(L.NE.1)CALL IMWRITE(0,LI,IMODL,256)
      ELSE
      :  DO (L2=1,255)
      :  :   IMODL(L2)=106214K
      :  :..FIN
      :  CALL IMWRITE(0,LI,IMODL,256)
      :..FIN
      ACCEPT "HISTO ENDED, ENTER 1 TO CONTINUE : ",ISTOP
      RETURN
      END
```

```
C***********************************************************************
C                                                                      *
C       HISTPR                                                         *
C                                                                      *
C       THIS PROGRAM PRINTS HISTOGRAMS AND STATISTICS                  *
C       FOR ALL SIGNATURES IN A FILE                                   *
C                                                                      *
C       SEQUENCE:  HISTPR HISTFILE SIGFILE                             *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT GEORGIA TECH EES                                    *
C                                                                      *
C       PROGRAMMER:  NICKOLAS L. FAUST                                 *
C                                                                      *
C***********************************************************************
      DIMENSION ICOUNT(4,100),IFIL(20),IMAX(4),ICOL(123)
      DIMENSION JFIL(20),COV(4,4),SM(4)
      INTEGER Z,ISW(2)
      COMMON /LBLANK/IBL
      DATA IBL /1H /
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,JFIL,ISW,IERR)
      ACCEPT "  WHICH OUTPUT DIVICE DO YOU WANT (10 OR 12) ?",Z
      CALL FOPEN(2,IFIL,"B")
      CALL FOPEN(3.JFIL,"B")
      READ BINARY(2)IT1,IT2,IT3,ID1,ID2,ID3
      READ BINARY(3)IT1,IT2.IT3,ID1,ID2,ID3
      WRITE(Z,100)IT1,IT2,IT3
      WRITE(Z,101)ID1,ID2,ID3
      FOREVER
      :  READ BINARY(2,END=120)NA1,NA2,NA3,NA4
      :  WRITE(Z,102)NA1,NA2,NA3,NA4
      :  READ BINARY(2)ICOUNT
      :  READ BINARY(3)NA1,NA2,NA3,NA4
      :  READ BINARY(3)NP,SM,COV
      :  WRITE(Z,102)NA1,NA2,NA3,NA4
      :  WRITE(Z)NP,SM,COV
      :  DO (I=1,4)IMAX(I)=0
      :  DO (I=1,4)
      :  :  DO (J=1,100)
      :  :  :  IF(ICOUNT(I,J).GT.IMAX(I))IMAX(I)=ICOUNT(I,J)
      :  :  :..FIN
      :  :  IF(IMAX(I).EQ.0)IMAX(I)=1
      :  :  DO (JJ=1,60)
      :  :  :  ICOUNT(I,JJ)=(ICOUNT(I,JJ)*10)/IMAX(I)
      :  :  :..FIN
      :  :..FIN
      :  DO (K=1,2)
      :  :  KO=2*K
      :  :  DO (K1=1,10)
      :  :  :  K2=11-K1
      :  :  :  DO (K3=1,60)
      :  :  :  :  K10=K3+2
      :  :  :  :  ICOL(K10)=IBL
      :  :  :  :  K11=63+K3
      :  :  :  :  ICOL(K11)=IBL
      :  :  :  :  IF(ICOUNT(KO,K3).GE.K2)ICOL(K11)=1H*
      :  :  :  :  K12=KO-1
      :  :  :  :  IF(ICOUNT(K12,K3).GE.K2)ICOL(K10)=1H*
      :  :  :  :..FIN
      :  :  :  ICOL(2)=1HI
      :  :  :  ICOL(63)=1HI
      :  :  :  WRITE(Z,104)ICOL
      :  :  :..FIN
      :  :  DO (KQ=1,123)ICOL(KQ)=1H=
      :  :  WRITE(Z,104)ICOL
      :  :  WRITE(Z,105)
      :  :  WRITE(Z,105)
      :  :  WRITE(Z,105)
      :  :  WRITE(Z,105)
      :  :  WRITE(Z,105)
      :  :..FIN
      :..FIN
```

```
100     FORMAT(2X,"TAPE IDENTIFIER - ",3I2)
101     FORMAT(2X,"SIGNATURE TAKEN ON - ",I2,"/",I2,"/",I2)
102     FORMAT( 1X,4A2)
104     FORMAT( 123A1)
106     FORMAT(4A2)
105     FORMAT(/////)
120     STOP
        END
```

```
C***************************************************************************
C                                                                          *
C        INITCL   (SUBROUTINE)                                             *
C                                                                          *
C        PURPOSE:                                                          *
C        INITIALIZES THE MEAN VECTORS AND WEIGHTS FOR THE CLUSTER          *
C        ING ALGORITHMS                                                    *
C                                                                          *
C        DESCRIPTION OF PARAMETERS                                         *
C                                                                          *
C        INPUT                                                             *
C        $NAMELIST-$ININIT                                                 *
C        VM - VECTOR MEANS                                                 *
C        NVM - NUMBER OF VECTORS IN VM                                     *
C        NVG - WEIGHT ASSOCIATED WITH EACH MEAN                            *
C        KNO - DIMENSION OF EACH VECTOR IN VM                              *
C        HOLLERITH OPTIONS                                                 *
C        ZERO - SETS INITIAL MEANS AND WEIGHTS EQUAL TO ZERO               *
C        OLD - RETURNS WITH PREVIOUSLY COMPUTED MEANS AND WEIGHTS          *
C        NEW - ALLOW MEANS AND WEIGHTS TO BE INPUT                         *
C                                                                          *
C        OUTPUT                                                            *
C        CALLING SEQUENCE                                                  *
C        VM - VECTOR MEANS                                                 *
C        NVM - NUMBER OF VECTORS IN VM                                     *
C        NVG - WEIGHT ASSOCIATED WITH EACH MEAN                            *
C        PRINT                                                             *
C        DISPLAYS INPUT IF CARD OPTION IS NEW                              *
C                                                                          *
C        REMARKS AND RESTRICTIONS                                          *
C        AFTER NAMELIST INPUT A CARD WITH THE WORD YES IS REQUIRE          *
C        INDICATING CORRECT INPUTS IF NOT REPEAT NAMELIST INPUTS           *
C                                                                          *
C***************************************************************************
C                                                                          *
C        CREATED AT NASA/JSC   (ASTEP)                                     *
C                                                                          *
C***************************************************************************
      SUBROUTINE INITCL(VM,NVG,NVM,KNO)
      DIMENSION VM(240),NVG(20)
      COMMON/INOUT/IOUT,INP
 1040 WRITE(IOUT,1050)
 1050 FORMAT(38H CHOOSE VALUES FOR INITIALIZATION FROM)
      WRITE(IOUT,1055)
 1055 FORMAT(15H ZERO  OLD  NEW)
      READ(INP,1030)IAN
 1030 FORMAT(A6)
      IF(IAN.EQ.4HZERO) GO TO 1100
      IF(IAN.EQ.3HOLD) GO TO 1200
      IF(IAN.EQ.3HNEW) GO TO 1150
      WRITE(IOUT,1060)IAN
 1060 FORMAT(1H ,A6,23H IS NOT A VALID CHOICE.)
      GO TO 1040
 1100 CONTINUE
      DO 51 I=1,240
 51   VM(I)=0.0
      DO 52 I=1,20
   52 NVG(I)=0
      NVM=1
      GO TO 1200
 1150 CONTINUE
 1170 WRITE(IOUT,1160)
 1160 FORMAT(21H $ININIT   VM,NVG,NVM)
      WRITE(IOUT,1022) NVM,(NVG(I),I=1,NVM)
 1022 FORMAT(7H NVM = ,I2,7H NVG = ,20I6)
      CALL MATPRT(VM,KNO,KNO,NVM,5HMEANS)
      WRITE(IOUT,1020)
 1020 FORMAT(32H TYPE YES IF INPUTS ARE CORRECT.)
      READ(INP,1030)IAN
      IF(IAN.NE.3HYES) GO TO 1170
 1200 CONTINUE
      RETURN
      END
```

```
C*****************************************************************************:
C                                                                              :
C         INPUTSIG                                                             :
C                                                                              :
C         ALLOWS MANUAL INPUT OF SIGNATURE FILE                                :
C                                                                              :
C*****************************************************************************:
C                                                                              :
C         CREATED AT GEORGIA TECH EES                                          :
C                                                                              :
C         PROGRAMMER:  NICKOLAS L. FAUST                                       :
C                                                                              :
C*****************************************************************************:
      DIMENSION COV(4,4),XM(4)
      CALL OPEN(3,"INSG",0,IE)
      CALL FOPEN(4,"HSIG","B")
      READ(3)NSIG
      ID1=01
      ID2=22
      ID3=77
      IT1=99
      IT2=99
      IT3=99
      WRITE BINARY(4)IT1,IT2,IT3,ID1,ID2,ID3
      DO (L=1,NSIG)
      :   WRITE(10,101)
      :   READ(3,100)NA1,NA2,NA3,NA4
      :   WRITE(10,102)
      :   READ(3)NP
      :   WRITE(10,103)
      :   READ(3)XM
      :   DO (K=1,4)
      :   :   WRITE(10,104)K
      :   :   READ(3)(COV(K,J),J=1,4)
      :   :..FIN
      :   WRITE BINARY(4)NA1,NA2,NA3,NA4
      :   WRITE BINARY(4)NP,XM,COV
      :..FIN
100   FORMAT(4A2)
101   FORMAT(2X,"INPUT NA1,NA2,NA3,NA4")
102   FORMAT(2X,"INPUT NUMBER OF POINTS")
103   FORMAT(2X,"INPUT (XM(I),I=1,4)")
104   FORMAT(2X,"INPUT ROW # ",I1," OF COV - (COV(K,J),J=1,4)")
      STOP
      END
```

```
C***************************************************************************
C                                                                          *
C        LINBOX  (SUBROUTINE)                                              *
C                                                                          *
C        USED TO CALCULATE EXTREMES FOR A LINEAR CLASSIFICATION            *
C                                                                          *
C***************************************************************************
C                                                                          *
C        CREATED AT GEORGIA TECH EES                                       *
C                                                                          *
C        PROGRAMMER:  NICKOLAS L. FAUST                                    *
C                                                                          *
C***************************************************************************
      SUBROUTINE LINBOX(AMEAN,BCOV,NSIG,ND)
      DIMENSION AMEAN(4,10),BCOV(4,4,10)
      INTEGER DELLIN
      COMMON/BOX/DELLIN(4,10,2)
      DO (K=1,NSIG)
      :  DO (I=1,ND)
      :  :  DIF=(SQRT(BCOV(I,I,K))/2.)*3.
      :  :  DELLIN(I,K,1)=AMEAN(I,K)-DIF
      :  :  DELLIN(I,K,2)=AMEAN(I,K)+DIF
      :  :..FIN
      :..FIN
      RETURN
      END
```

```
C***************************************************************************
C
C         LINCLASS
C
C         THIS ROUTINE CLASSIFIES POLYGONS WITH A  LINEAR CLASSIFIER
C         AND CREATES THRESHOLD ARRAY
C
C         SEQUENCE:  LINCLASS INPUT DATAP SIGFIL LINTAP
C
C***************************************************************************
C
C         CREATED AT GEORGIA TECH EES
C
C         PROGRAMMER:  NICKOLAS FAUST
C
C***************************************************************************
      DIMENSION THRESH(812),ISW(2)
      INTEGER DELLIN
      COMMON/A/ AMEAN(4,10),BCOV(4,4,10),IVX(101),IVY(101),B(400),DET(10
     1,LA(133),NVG(10),COUNT(10),IBUF(1650),I1(30),I2(30),I3(30),I4(30)
     2,IORDER(10),NAM1(10),NAM2(10),NAM3(10),NAM4(10)
      COMMON/B/JBUF(4,810),IDUM(812)
      COMMON/BOX/DELLIN(4,10,2)
      IP=12
C
C         FILE STATEMENTS
C
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I2,ISW,IERR)
      CALL COMARG(1,I3,ISW,IERR)
      CALL COMARG(1,I4,ISW,IERR)
C
      CALL OPEN(2,I1,0,IE)
      CALL MTOPD(5,I4,0,IE)
C
C         OPEN TAPE FILE
C
      CALL MTOPD(3,I2,0,IE)
      ND=4
      NUN1=2
      NUN2=4
      READ(2,200)NSIG
      WRITE(IP)NSIG
C
C         GET SIGNATURES  FOR CLASSIFICATION
C
      CALL GSIG(AMEAN,BCOV,NSIG,NUN1,NUN2,I3,IORDER,NAM1,NAM2,NAM3,NAM4)
C
      IYMIN=1000
      CALL LINBOX(AMEAN,BCOV,NSIG,ND)
      IXMIN=1000
      IYMAX=0
      WRITE(IP,202)
      READ(2,200)NC
      DO (I=1,NC)
      :   WRITE(IP,205)I
      :   READ(2,206)IVX(I),IVY(I)
      :   WRITE(IP,206)IVX(I),IVY(I)
      :   IF(IVY(I).LT.IYMIN)IYMIN=IVY(I)
      :   IF(IVX(I).LT.IXMIN)IXMIN=IVX(I)
      :   IF(IVY(I).GT.IYMAX)IYMAX=IVY(I)
      :..FIN
      IVX(NC+1)=IVX(1)
      IVY(NC+1)=IVY(1)
      NV=NC
      IDEL=IYMAX-IYMIN
      ISKIP=IYMIN+1
```

```
C
C
C         SKIP RECORDS
C
      CALL MTDIO(3,30000K+ISKIP,IBUF,IS,IEE)
      DO (LL=1,812)
      :   IDUM(LL)=0
      :..FIN
      IDUM(1)=IDEL
      IDUM(2)=IXMIN
      WRITE(IP)IDUM(1),IDUM(2)
      CALL MTDIO(5,50000K+812,IDUM,IS,IER,NW)
      WRITE(IP)NW
      DO (J=1,IDEL)
      :   CALL MTDIO(3,0,IBUF,IS,IE,NW)
      :   ISW=2
      :   CALL POLY2(ISKIP+J-1,ISW,IVX,IVY,NV,LA)
      :   JS=LA(2)
      :   JF=LA(3)
      :   CALL UNPAC4(IBUF,JBUF,JS,JF,810,1650)
      :   JQ=JF-JS+1
C     :
C     :
C     :
      :   NN=NSIG
      :   CALL LINEAR(JBUF,NN,IC,ND,NN,AMEAN,BCOV,JQ,IDUM,NVG,THRESH)
C     :
C     :
C     :
      :   WRITE(10,207) J
      :   JMOVE=JS-1
      :   DO   (LL=1,810)
      :   :   LV=813-LL
      :   :   IDUM(LV)=IDUM(LV-2)
      :   :   THRESH(LV)=THRESH(LV-2)
      :   :..FIN
      :   IDUM(1)=JMOVE
      :   IDUM(2)=JQ
      :   CALL MTDIO(5,50000K+812,IDUM,IS,IER)
      :   CALL MTDIO(5,50000K+812,THRESH,IS,IER)
      :   TOT=TOT+JQ
      :   DO   (K=1,JQ)
      :   :   LSUB=IDUM(K+2)
      :   :   COUNT(LSUB)=COUNT(LSUB)+1
      :   :..FIN
      :..FIN
      DO (K=1,NSIG)
      :   PER=(COUNT(K)*100)/TOT
      :   WRITE(12,102)K,COUNT(K),PER,NAM1(K),NAM2(K),NAM3(K),NAM4(K)
      :..FIN
      CALL MTDIO(5,60000K,IDUM,IS,IER)
      CALL MTDIO(5,60000K,IDUM,IS,IER)
 102  FORMAT(2X,"CLASS   ",I4,"  NUMBER  ",F7.0,"  PERCENT  ",F4.0,2X,4A2)
 103  FORMAT(2X,4A2)
 200  FORMAT(I2)
 202  FORMAT(2X,"INPUT # OF CORNERS")
 205  FORMAT(2X,"INPUT CORNER # ",I3,"J,I")
 206  FORMAT(2I4)
 207  FORMAT(2X,"LINE #",I5," PROCESSED")
      STOP
      END
```

```
C*************************************************************************
C
C        LINEAR  (SUBROUTINE)
C
C        CLASSIFIES LANDSAT DATA WITH LINEAR DISTANCE
C
C*************************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:  NICKOLAS L. FAUST
C
C*************************************************************************
      SUBROUTINE LINEAR(V,NVM,ICOUNT,ND,NSIG,AMEAN,BCOV,NL,IDUM,NVG,
     1THRESH)
      DIMENSION AMEAN(ND,NVM),BCOV(ND,ND,NVM)
      INTEGER DELLIN
      DIMENSION V(ND,NL)
      DIMENSION IDUM(812),THRESH(812),NVG(10)
      INTEGER V
      COMMON/BOX/DELLIN(4,10,2)
      ICOUNT=1
      DO (LL=1,NL) IDUM(LL)=9
      DO (LL=1,NL) THRESH(LL)=0.
      JPT=0
      FOREVER
      :   JPT=JPT+1
      :   IF(JPT.GT.NL)RETURN
      :   IMIN=1
      :   DIST=1.E+6
      :   DO (K=1,NVM)
      :   :   KSUM=0
      :   :   SUM=0.0
      :   :   DO (L=1,ND)
      :   :   :   IF(V(L,JPT).GT.DELLIN(L,K,1).AND.V(L,JPT).LT.DELLIN(L,K,2)
      :   :   :   :   SUM=SUM+ABS(AMEAN(L,K)-V(L,JPT))
      :   :   :   :   KSUM=KSUM+1
      :   :   :   :..FIN
      :   :   :..FIN
      :   :   IF(KSUM.EQ.4)
      :   :   :   IF(SUM.LT.DIST)
      :   :   :   :   DIST=SUM
      :   :   :   :   IMIN=K
      :   :   :   :..FIN
      :   :   :..FIN
      :   :..FIN
      :   THRESH(JPT)=DIST
      :   IDUM(JPT)=IMIN
      :   NVG(IMIN)=NVG(IMIN)+1
      :..FIN
100   FORMAT(2X,"ENTERED LINEAR ",I6," TIMES")
101   FORMAT(2X,"EXITED LINEAR")
      RETURN
      END
```

```
C***************************************************************************
C                                                                          *
C        LISTALL                                                           *
C                                                                          *
C        PRINTS ALL SIGNATURES , VERTICIES , OR HISTOGRAMS                 *
C        FOR A SPECIFIC FILE                                               *
C                                                                          *
C        SEQUENCE:  LISTALL FILE                                           *
C                                                                          *
C***************************************************************************
C                                                                          *
C        CREATED AT GEORGIA TECH EES                                       *
C                                                                          *
C        PROGRAMMER:  NICKOLAS L. FAUST                                    *
C                                                                          *
C***************************************************************************
      DIMENSION IFIL(20),SM(4),COV(4,4),ICOUNT(4,100)
      DIMENSION IVX(101),IVY(101)
      DIMENSION ISWS(2),FIELD(17)
      CALL OPEN(1,"COM.CM",1,IE)
      CALL COMARG(1,FIELD,ISWS,IE)
      CALL COMARG(1,FIELD,ISWS,IE)
      CALL FOPEN(2,FIELD,"B")
      WRITE(10,555)
      READ(11)IOUT
555   FORMAT(2X,"  INPUT OUTPUT DEVICE # (10,12)")
      WRITE(10,401)
      READ(11)ICON
      WRITE(10,403)
      READ(11)ITOT
      READ BINARY(2)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      WRITE(IOUT,100)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      FOREVER
      :  READ BINARY(2,END=120)NS1,NS2,NS3,NS4
      :  IF(ICON.EQ.1)READ BINARY(2)NP,SM,COV
      :  IF(ICON.EQ.2)
      :  :  READ BINARY(2)K,IYMIN,IYMAX
      :  :  DO (K1=1,K)READ BINARY(2)K2,IVX(K1),IVY(K1)
      :  :..FIN
      :  IF(ICON.EQ.3)READ BINARY(2)ICOUNT
      :  WRITE(IOUT,101)NS1,NS2,NS3,NS4
      :  IF(ICON.EQ.1)
      :  :  IF(ITOT.EQ.1)WRITE(IOUT)NP,SM,COV
      :  :..FIN
      :  IF(ICON.EQ.2)
      :  :  IF(ITOT.EQ.1)
      :  :  :  WRITE(IOUT)K,IYMIN,IYMAX
      :  :  :  DO (K1=1,K)WRITE(IOUT)K1,IVX(K1),IVY(K1)
      :  :  :..FIN
      :  :..FIN
      :  IF(ICON.EQ.3)
      :  :  IF(ITOT.EQ.1)WRITE(IOUT)ICOUNT
      :  :..FIN
      :..FIN
100   FORMAT(1X,6I2)
101   FORMAT(1X,4A2/)
401   FORMAT(2X,"INPUT SWITCH , 1 -SIG , 2 -VER , 3 -HIS")
402   FORMAT(4I10)
403   FORMAT(2X,"  TOTAL LIST - 1 , OR NAME LIST - 0 ?")
120   STOP
      END
```

```
C****************************************************************************
C
C         LISTSIG
C
C         PRINTS ALL SIGNATURES FOR A GIVEN FILE
C
C         SEQUENCE:   LISTSIG FILE
C
C****************************************************************************
C
C         DESIGNED AT GEORGIA TECH EES
C
C         PROGRAMMER:   NICKOLAS L. FAUST
C
C****************************************************************************
      DIMENSION IFIL(20),SM(4),COV(4,4),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL FOPEN(2,IFIL,"B")
      READ BINARY(2)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      WRITE(12,100)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      FOREVER
      :   READ BINARY(2,END=120)NS1,NS2,NS3,NS4
      :   READ BINARY(2)NP,SM,COV
      :   WRITE(12,101)NS1,NS2,NS3,NS4
      :   WRITE(12)NP,SM,COV
      :..FIN
100   FORMAT(1X,6I2)
101   FORMAT(1X,4A2)
120   STOP
      END
```

```
C***********************************************************************
C                                                                      *
C        MATIN   (SUBROUTINE)                                          *
C                                                                      *
C        MATRIX INVERSION PROGRAM                                      *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT NASA/JSC   (ASTEP)                                 *
C                                                                      *
C***********************************************************************
      SUBROUTINE MATIN(A,N,B,M,KEY,DETERM)
      DIMENSION A(N,N),B(N),IPIVOT(20),INDEX(20,2)
      DOUBLE PRECISION  PIVOT(20), T,SWAP,DETERM,AMAX,ZERO,A,B
C
C      INITIALIZATION
    5 KEY = N
   10 DETERM= 1.D+0
   15 DO 20 J=1,N
   20 IPIVOT(J)=0
   30 DO 550 I=1,N
C
C     SEARCH FOR PIVOT ELEMENT
C
   40 AMAX= 0.D+0
   45 DO 105 J=1,N
   50 IF (IPIVOT(J)-1) 60,105,60
   60 DO 100 K=1,N
   70 IF (IPIVOT(K)-1) 80,100,740
   80 IF (DABS(AMAX)-DABS(A(J,K)))  85,100,100
   85 IROW=J
   90 ICOLUM=K
   95 AMAX=A(J,K)
  100 CONTINUE
  105 CONTINUE
      ZERO = 1.D-16
  107 IF(DABS(AMAX) - ZERO) 745,745,110
  110 IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
C
C      INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
  130 IF (IROW-ICOLUM) 140,260,140
  140 DETERM=-DETERM
  150 DO 200 L=1,N
  160 SWAP=A(IROW,L)
  170 A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
  205 IF(M) 260,260,210
  210 SWAP = B(IROW)
  230 B(IROW) = B(ICOLUM)
  250 B(ICOLUM) = SWAP
  260 INDEX(I,1)=IROW
  270 INDEX(I,2)=ICOLUM
  310 PIVOT(I)=A(ICOLUM,ICOLUM)
```

```
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  330 A(ICOLUM,ICOLUM)=.1D+1
  340 DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
  355 IF(M) 380,380,360
  360 B(ICOLUM) = B(ICOLUM)/PIVOT(I)
C
C     REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
  390 IF(L1-ICOLUM) 400,550,400
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM)= .0D+0
  430 DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF(M) 550,550,460
  460 B(L1) = B(L1) - B(ICOLUM)*T
  550 CONTINUE
C
C     INTERCHANGE COLUMNS
C
  600 DO 710 I=1,N
  610 L=N+1-I
  620 IF (INDEX(L,1)-INDEX(L,2)) 630,710,630
  630 JROW=INDEX(L,1)
  640 JCOLUM=INDEX(L,2)
  650 DO 705 K=1,N
  660 SWAP=A(K,JROW)
  670 A(K,JROW)=A(K,JCOLUM)
  700 A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
      DO 800 I=1,N
      J=N+1-I
  800 DETERM=DETERM*PIVOT(J)
  740 RETURN
  745 DETERM = 0.D+0
  746 KEY = I - 1
  750 RETURN
      END
```

```
C***********************************************************************
C                                                                      *
C        MATPRT                                                        *
C                                                                      *
C        PRINTS A REAL MATRIX                                          *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT NASA/JSC   (ASTEP)                                 *
C                                                                      *
C***********************************************************************
      SUBROUTINE MATPRT(MAT,NR,RD,NC,NAM)
      INTEGER RD,P,Q
      REAL MAT(RD,NC)
1000  FORMAT(1H ,I2,6F10.3)
1010  FORMAT(1H ,6I10)
      KOUT=12
      WRITE(KOUT,1020)NAM,NR,NC
1020  FORMAT(1H ,15X,A2,I6,3H BY,I3)
      DO 100 I=1,NR
      DO 100 J=1,NC
      IF(MAT(I,J))150,100,150
100   CONTINUE
      WRITE(KOUT,1030)
1030  FORMAT(1H ,15X,12H ALL ZEROES.)
      GO TO 30
150   CONTINUE
      P=0
      Q=-5
10    P=P+6
      Q=Q+6
      IF(NC.LT.P)P=NC
      WRITE(KOUT,1010)(J,J=Q,P)
      WRITE(KOUT,1000)
      DO 20 I=1,NR
      WRITE(KOUT,1000)I,(MAT(I,J),J=Q,P)
 20   CONTINUE
      IF(NC.GT.P)GO TO 10
30    CONTINUE
      WRITE(KOUT,1000)
      RETURN
      END
```

```
C***************************************************************************
C
C        MESS
C
C        UNPACKS AND DISPLAYS MULTISPECTRAL 12 CHANNEL
C        DAEDALEUS SCANNER DATA AND DISPOSES REFORMATED DATA
C        TO TAPE
C
C        SEQUENCE:  MESS MTU:F MTU:F
C
C***************************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:  MICHAEL D. FURMAN
C
C***************************************************************************
      INTEGER INPUT(700),IOUT(850),ITAPE1(10),ITAPE2(10),IMAG2(1700)
      INTEGER IMAG3(1100),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,ITAPE1,ISW,IERR)
      CALL COMARG(1,ITAPE1,ISW,IERR)
      CALL COMARG(1,ITAPE2,ISW,IERR)
      CALL MTOPD(2,ITAPE1,0,IE)
      CALL MTOPD(3,ITAPE2,0,IE)
      ACCEPT "START WITH WHAT ELEMENT ", IEL
      FOREVER
      :  CALL MTDIO(2,0,INPUT,IS,IE,IC)
      :  L=1
      :  DO (J1=1,565,3)
      :  :  M0=IAND(ISHFT(INPUT(J1),2),177400K)
      :  :  M1=IOR(M0,IAND(ISHFT(INPUT(J1),6),300K))
      :  :  IOUT(L)=IOR(M1,ISHFT(INPUT(J1+1),-10))
      :  :  M2=IOR(ISHFT(INPUT(J1+1),10),IAND(ISHFT(INPUT(J1+2),-6),1400I
      :  :  IOUT(L+1)=IOR(M2,IAND(ISHFT(INPUT(J1+2),-2),377K))
      :  :  L=L+2
      :  :..FIN
      :  CALL UPAC8(IOUT,IMAG2,850)
      :  DO (I=1,40)
      :  :  IF ((IMAG2(I).EQ.255).AND.(IMAG2(I+1).LE.10)) IPAS1=I+4
      :  :..FIN
      :  IPAS2=0
      :  DO (I=IPAS1,512)
      :  :  IF ((IMAG2(I).EQ.255).AND.(IMAG2(I+1).LE.10)) IPAS2=I+4
      :  :..FIN
      :  L30=1
      :  WHEN (IPAS2.GT.0)
      :  :  DO (I=IPAS2,756)
      :  :  :  IMAG3(L30)=IMAG2(I)
      :  :  :  L30=L30+1
      :  :  :..FIN
      :  :..FIN
      :  ELSE
      :  :  L31=1
      :  :  DO (I=IPAS1,756)
      :  :  :  IMAG3(L31)=IMAG2(I)
      :  :  :  L31=L31+1
      :  :  :..FIN
      :  :..FIN
      :  CALL PAC8(IMAG3(IEL),IOUT,512)
      :  CALL RIMWRITE(0,0,IOUT,256)
      :  CALL MTDIO(3,50000K+850,IMAG3,IS,IE,IC)
      :..FIN
      STOP
      END
```

```
C***************************************************************************
C                                                                          *
C       MODIFY   (SUBROUTINE)                                              *
C                                                                          *
C    PURPOSE                                                               *
C             COMPUTES WEIGHTED AVERAGE OF TWO MEAN VECTORS                *
C                                                                          *
C    DESCRIPTION OF PARAMETERS                                             *
C                                                                          *
C       INPUT                                                              *
C         CALLING SEQUENCE                                                 *
C             V1 - 1 ST VECTOR MEAN                                        *
C             V2 - 2 ND VECTOR MEAN                                        *
C             N1 - NUMBER OF VECTORS USED TO COMPUTE V1                    *
C             N2 - NUMBER OF VECTORS USED TO COMPUTE V2                    *
C             ND - DIMENSION OF V1 AND V2                                  *
C                                                                          *
C       OUTPUT                                                             *
C         CALLING SEQUENCE                                                 *
C             V1 - WEIGHTED AVERAGE OF INPUT V1 AND V2                     *
C             N1 - NUMBER OF VECTORS USED TO COMPUTE OUTPUT V1             *
C                                                                          *
C***************************************************************************
C                                                                          *
C       CREATED AT NASA/JSC   (ASTEP)                                      *
C                                                                          *
C***************************************************************************
      SUBROUTINE MODIFY ( V1, V2, N1, N2, ND )
      DIMENSION V1(ND),V2(ND)
      REAL N1
      XN1 = (N1)
      XN2 = FLOAT(N2)
      XN1N2 = 1.0/(N1+FLOAT(N2))
      DO 10 I=1,ND
   10 V1(I) = ( XN1*V1(I) + XN2*V2(I) )*XN1N2
      N1 = N1 + FLOAT(N2)
      RETURN
      END
```

```
C**********************************************************************
C
C         PACK    (SUBROUTINE)
C
C     PURPOSE
C              PACKS A STORAGE ARRAY TO ELIMINATE A VACATED SLOT, MOVES   :
C              ALL VECTORS WITH INDEX GREATER THAN INDEX OF VACATED      :
C              SLOT DOWN ONE POSITION IN THE ARRAY                       :
C                                                                        :
C     DESCRIPTION OF PARAMETERS                                          :
C                                                                        :
C         INPUT                                                          :
C           CALLING SEQUENCE                                             :
C              V - DATA ARRAY                                            :
C              ND - DIMENSION OF EACH VECTOR IN V                        :
C              NV - NUMBER OF VECTORS IN V                               :
C              IND - INDEX IN V OF VACATED SLOT                          :
C         OUTPUT                                                         :
C           CALLING SEQUENCE                                             :
C              V - PACKED ARRAY                                          :
C                                                                        :
C**********************************************************************
C                                                                        :
C         CREATED AT NASA/JSC    (ASTEP)                                 :
C                                                                        :
C**********************************************************************
      SUBROUTINE PACK(V,ND,NV,IND)
      DIMENSION V(ND,NV)
      IF(IND.EQ.NV) RETURN
      I1=IND+1
      DO 20 I=I1,NV
      I2=I-1
      DO 10 J=1,ND
   10 V(J,I2)=V(J,I)
   20 CONTINUE
      RETURN
      END
```

```
C****************************************************************************
C                                                                           *
C        POLY2  (SUBROUTINE)                                                *
C                                                                           *
C        CALCULATES POLYGON INTERSECTIONS FOR LINE AND POLYGON              *
C                                                                           *
C****************************************************************************
C                                                                           *
C        CREATED AT NASA/ERL                                                *
C                                                                           *
C        PROGRAMMER:   RONNIE PIERSON                                       *
C                                                                           *
C****************************************************************************
         SUBROUTINE POLY2(JY,ISW,IX,IY,N,LA)
C        VERTEX -(IX(I),IY(I))=(ELEMENT,SCAN)  FOR ITH VERTEX.
         DIMENSION IX(101),IY(101),D(100),F(101),LA(133),S(101)
         IF(ISW.EQ.1)GO TO 1
C        SLOPE STORE BLOCK X/Y
         DO 20 I=1,N
         IF(IY(I).EQ.IY(I+1))GO TO 20
         D(I)=FLOAT(IX(I+1)-IX(I))/FLOAT(IY(I+1)-IY(I))
20       CONTINUE
1        Y=FLOAT(JY)
         M=0
         NOV=0
         DO 40 I=1,N
C        LOCATION OF INTERVALS SUCH THAT IY(I).LE.JY.LT.IY(I+1). SCAN=JY
         IF(IY(I).EQ.JY)GO TO 30
         IF(IY(I).LT.JY)GO TO 22
         IF(IY(I+1).LT.JY)GO TO 28
         GO TO 40
22       IF(IY(I+1).GT.JY)GO TO 28
         GO TO 40
C        POLYGON BOUNDARY COUNTER AND FUNCTIONAL VALUES. -NON VERTICES-
28       M=M+1
         F(M)=D(I)*(Y-FLOAT(IY(I)))+FLOAT(IX(I))
         GO TO 40
C        POLYGON BOUNDARY COUNTER AND FUNCTIONAL VALUES. -VERTICIES-
C        NOV=NUMBER OF VERTICES
30       M=M+1
         NOV=NOV+1
         F(M)=FLOAT(IX(I))
         LA(NOV)=IX(I)
40       CONTINUE
         K=M
C        BOUNDARY SORT - INCREASING ORDER.
         DO 50 J=1,K
         S(J)=F(1)
         IND=1
         DO 48 L=1,M
         IF(F(L).GE.S(J))GO TO 48
         S(J)=F(L)
         IND=L
48       CONTINUE
         F(IND)=10000
50       CONTINUE
C        FOR (NOV.LT.2)  INTERVAL S(J),S(J+1)  MEMBERSHIP CAN BE DETERMINED
         IF(NOV.EQ.0)GO TO 500
         IF(NOV.EQ.1)GO TO 490
C        DATA SHIFT FOR CONSISTENCE AFTER MEMBERSHIP IS DETERMINED
         DO 52 K=1,M
52       F(K)=S(K)
         NOI=M-1
         M=0
```

```
C
C        INTERVAL F(K),F(K+1) MEMBERSHIP SECTION FOR (NOV.GE.2).
C
         DO 200 K=1,NOI
C        A IS THE POINT CHECKED TO DETERMINE INTERVAL F(K),F(K+1) MEMBERS
         A=(F(K)+F(K+1))/2.
54       L=0
         J=0
         LV=0
         JV=0
         IN=0
         DO 122 I=1,N
C        LOCATION OF INTERVALS SUCH THAT IX(I).LE.A.LT.IX(I+1)
         CX=FLOAT(IX(I))
         DX=FLOAT(IX(I+1))
         IF(CX.EQ.DX)GO TO 122
         IF(CX.EQ.A)GO TO 128
         IF(CX.LT.A)GO TO 124
         IF(DX.LT.A)GO TO 128
         GO TO 122
124      IF(A.GE.DX)GO TO 122
128      CY=FLOAT(IY(I))
         DY=FLOAT(IY(I+1))
         DM=(DY-CY)/(DX-CX)
C        BOUNDARY POINTS (A,F(A)) FOR GIVEN INTERVAL IX(I).LE.A.LT.IX(I+1)
         FX=DM*(A-CX)+CY
C        IN=1 INDICATES F(A)=JY
         IF(FX.EQ.Y)IN=1
         IF(FX.LT.Y)GO TO 130
C        J INDICATES F(A).GT.JY.
C
         J=J+1
         IF(FX.NE.CY)GO TO 122
         IF(A.NE.CX)GO TO 122
C
C        JV INDICATES F(A)=IY(I).GT.JY, FOR SOME I.
C
         JV=JV+1
         GO TO 122
C
C        L INDICATES F(A).LT.JY.
C
130      L=L+1
         IF(FX.NE.CY)GO TO 122
         IF(A.NE.CX)GO TO 122
C
C        LV INDICATES F(A)=IY(I).LT.JY. FOR SOME I.
C
         LV=LV+1
122      CONTINUE
```

```
C
C       INTERVAL F(K),F(K+1) MEMBERSHIP DETERMINATION.
C
        IF(IN.EQ.1)GO TO 150
        IF(JV.EQ.0)GO TO 140
        J=L
        IF(LV.EQ.0)GO TO 140
C
C       IF NO DETERMINATION CAN BE MADE, ADD ANOTHER INCREMENT AND TRY AGA
C
        A=A+.01
        GO TO 54
140     L=2*(J/2)
C
C       IF(J.NE.L) THE INTERVAL F(K),F(K+1) IS IN POLYGON.
C
        IF(J.NE.L)GO TO 150
C
C       CHECK FOR VERTEX AT (F(K);JY)
C
        DO 146 J=1,NOV
        CX=FLOAT(LA(J))
        IF(F(K).NE.CX)GO TO 146
C
C       VERTEX (F(K),JY) INCLUDED.
C
        M=M+1
        S(M)=F(K)
        M=M+1
        S(M)=F(K)
146     CONTINUE
        IF(K.NE.NOI)GO TO 200
        FX=F(K+1)
        DO 148 J=1,NOV
        CX=FLOAT(LA(J))
        IF(FX.NE.CX)GO TO 148
        M=M+1
        S(M)=FX
        M=M+1
        S(M)=FX
148     CONTINUE
        GO TO 200
C
C       INTERVAL F(K),F(K+1) INCLUDED
C
150     M=M+1
        S(M)=F(K)
        M=M+1
        S(M)=F(K+1)
200     CONTINUE
        GO TO 500
```

```
C
C        ALL INTERVALS FORTHCOMING ARE BOUNDARY TO BOUNDARY ON JY
C
C        CHECK FOR INTERVAL THAT CONTAINS ONLY A VERTEX
C
490      L=2*(M/2)
         IF(L.EQ.M)GO TO 500
         VAV=FLOAT(LA(1))
         M=M+1
         K=M
492      K=K-1
         IF(S(K).EQ.VAV)GOTO 494
         S(K+1)=S(K)
         GO TO 492
C
C        STOP INSERT FOR VERTEX LOOP
C
494      S(K+1)=VAV
C
C        IF(M.EQ.0)NO POINTS ON SCAN JY ARE INCUDED
C
500      IF(M.EQ.0)GO TO 555
         I=0
C
C        LOOP START AND STOP ROUND OFF TO MIN AND MAX INTEGER VALUES INCL
C
501      I=I+1
         LA(I)=S(I)+.999999
         I=I+1
         LA(I)=S(I)
         IF(I.LT.M) GO TO 501
         I=-1
C
C        INTERVAL(START.GT.STOP)COMPRESS
C
504      I=I+2
505      IF(LA(I).LE.LA(I+1))GO TO 510
         M=M-2
         IF(M.EQ.0)GO TO 555
         IF(I.GT.M)GO TO 511
         DO 506 K=I,M
506      LA(K)=LA(K+2)
         GO TO 505
510      IF((I+1).LT.M)GO TO 504
511      I=0
C
C        (LOOPSTOP ON INTERVAL(J).EQ.LOOP START ON INTERVAL(J+1))COMPRESS
C
512      I=I+2
513      IF(I.EQ.M)GO TO 555
514      IF(LA(I).NE.LA(I+1))GO TO 512
         M=M-2
         DO 516 K=I,M
516      LA(K)=LA(K+2)
         GO TO 513
C
C        LA(1)=NUMBER OF LOOPS RETURNED
C
555      IF(M.EQ.0) GO TO 560
         DO 557 I=1,M
         J=M-I+1
557      LA(J+1)=LA(J)
560      LA(1)=M/2
         RETURN
         END
```

```
C***********************************************************************
C                                                                      *
C       POLYCL                                                         *
C                                                                      *
C       PERFORMS CLUSTERING OPERATION                                  *
C                                                                      *
C       SEQUENCE:  POLYCL INPUT OUTPUT                                 *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT NASA/JSC   (ASTEP)                                  *
C                                                                      *
C***********************************************************************
      COMMON/UNTNUM/IMGUNT,DATUNT
      COMMON/BLANK/KNUM
      INTEGER CAR,BUF,ISW(2)
      REAL NVG
      COMMON/COL/JS,JF
      COMMON/BOUND/YMIN,XMIN,YMAX,XMAX
      INTEGER YMIN,YMAX,XMIN,XMAX
      DIMENSION JPX(101),JPY(101),LA(133)
      COMMON/NVEC/NVM
      COMMON/BUFFER/BUF(3300)
      COMMON/A1/IOUT(812)
      INTEGER DATUNT
      COMMON/INOUT/NOUT,NIN
      COMMON/CHARAC/CAR
      COMMON/DIST/IDIST
      INTEGER PLIST
      DIMENSION VM(240),AD(20,20)
      DIMENSION NVG(20),PLIST(20),CAR(20),IACOP(4)
      DIMENSION RM(20),RV(20)
      DIMENSION VMP(60),VAR(60)
      DIMENSION ACRE(20),I1(30),I2(30)
C
      C=3.
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I2,ISW,IERR)
      CALL MTOPD(4,I1,0,IER)
      CALL MTOPD(3,I2,0,IER)
      RP=3
      S=1.
      R1=20.
      R2=20.
      NVMMAX=15
      NPT=100
      NET=500
      NMT=100
      IP=0
      IACOP(1)=2HME
      IACOP(2)=2HSI
      IACOP(3)=2HAN
      IACOP(4)=2HQU
      ND=4
      NRT=1
      IMGUNT=3
      DATUNT=4
      NOSCAL=1
      NBUFSZ=3260
      IQ=NBUFSZ/(ND+2)
      IBUF2=NBUFSZ-IQ+1
      IBUF1=IBUF2-IQ
      NIN=11
      NOUT=10
```

```
      CAR(1)=1HA
      CAR(2)=1H.
      CAR(3)=1H:
      CAR(4)=1H-
      CAR(5)=1H,
      CAR(6)=1H/
      CAR(7)=1H+
      CAR(8)=1HO
      CAR(9)=1HX
      CAR(10)=1H#
      CAR(11)=1H$
      CAR(12)=1H%
      CAR(13)=1HB
      CAR(14)=1H@
      CAR(15)=1H*
C              USER INPUTS
C
1     CONTINUE
      WRITE(NOUT,1008)
 1008 FORMAT(2X,'INPUT VALUES FOR C, RP, R1, R2 AND NVMMAX')
      READ(NIN)C,RP,R1,R2,NVMMAX
      WRITE(NOUT)C,RP,R1,R2,NVMMAX
      WRITE(NOUT,102)
 102  FORMAT(22H TYPE YES IF INPUTS OK)
      READ(NIN,104)IAN
 104  FORMAT(A6)
      IF(IAN.NE.3HYES) GO TO 1
      IF(NVMMAX.GT.20) NVMMAX=20
C
C              FIRST PASS INITIALIZATION
C
      CALL INITCL(VM,NVG,NVM,ND)
      WRITE(10,199)
199   FORMAT(2X,"INPUT 1 FOR POLY , 0 - NORMAL")
      READ(11)IPOLY
      IF(IPOLY.NE.1)GO TO 201
      WRITE(10,202)
202   FORMAT(2X,"INPUT # OF CORNERS")
      READ(11)NV
      DO 204 I=1,NV
      WRITE(10,205)I
205   FORMAT(2X,"INPUT CORNER #",I3," J,I ")
204   READ(11)JPX(I),JPY(I)
      JPX(NV+1)=JPX(1)
      JPY(NV+1)=JPY(1)
201   CONTINUE
      JMIN=10000
      IMAX=0
      IMIN=10000
      DO 405 K1=1,NV
      IF(JPX(K1).LT.JMIN)JMIN=JPX(K1)
      IF(JPY(K1).LT.IMIN)IMIN=JPY(K1)
405   IF(JPY(K1).GT.IMAX)IMAX=JPY(K1)
      NRT=IMAX-IMIN+1
      DO 406 K2=1,812
406   IOUT(K2)=0
      IOUT(1)=NRT
      IOUT(2)=JMIN
      LINIT=IMIN
      LIN=IMIN+1
      CALL MTDIO(3,50000K+812,IOUT,IS1,IER)
      CALL MTDIO(4,30000K+LIN,IOUT,IS1,IER)
      INRT=0
      NEC=0
      NMC=0
      NPC=0
      IPASS=1
      JPTP=0
      RM(1)=0.
      RV(1)=0.
      DO 8 I=1,ND
    8 VMP(I)=0.
      DO 10 I=1,NVM
   10 PLIST(I)=I
```

```
C
C               FIRST PASS PROCESSING
C
   20 INRT=INRT+1
      IF(INRT.GT.NRT) GO TO 50
      IL=LINIT+INRT-1
      ISW=IL+1
      CALL POLY2(IL,ISW,JPX,JPY,NV,LA)
      JS=LA(2)
      JF=LA(3)
      IF(JS.EQ.0)JS=1
      WRITE(NOUT)JS,JF,INRT,"1"
      CALL UNPAC1
      NX=JF-JS+1
      CALL CLUSTA(BUF(1),VM,ND,NX,NVM,NVMMAX,NVG,C,S,RP,R1,NPC,
     *NPT,PLIST,NEC,NET,NMIN,NMC,NMT,IPASS,BUF(IBUF1),BUF(IBUF2),
     *IP,JPTP,RM,RV,VMP,VAR)
      JPTP=JPTF+NX
      GO TO 20
C
C               SPECIAL ELIMINATION AND MERGER TESTS
C
   50 NX=0
      JPTP=0
      NEC=NET
      NMC=NMT
      CALL CLUSTA(BUF(1),VM,ND,NX,NVM,NVMMAX,NVG,C,S,RP,R1,NPC,NPT,
     *PLIST,NEC,NET,NMIN,NMC,NMT,IPASS,BUF(IBUF1),
     *BUF(IBUF2),IP,JPTP,RM,RV,VMP,VAR)
C
C               SECOND PASS INITIALIZATION
C
      INRT=0
      NBACK=LIN+NRT
      CALL MTDIO(4,40000K+NBACK,BUF,IS,IE)
      WRITE(10,222)NBACK
222   FORMAT(2X,"  BACKSPACED ",I10," LINES")
      NEC=0
      IF(LIN.LE.0)GO TO 444
      CALL MTDIO(4,30000K+LIN,BUF,IS,IE)
444   CONTINUE
      NMC=0
      NPC=0
      IPASS=2
      DO 60 I=1,NVM
      PLIST(I)=I
   60 NVG(I)=0
C
C               SECOND PASS PROCESSING
C
   62 INRT=INRT+1
      IF(INRT.GT.NRT) GO TO 70
      IL=LINIT+INRT-1
      ISW=IL+1
      CALL POLY2(IL,ISW,JPX,JPY,NV,LA)
      JS=LA(2)
      JF=LA(3)
      JQ=JF-JS+1
      DO 402 LL=1,812
402   IOUT(LL)=0
      IOUT(1)=JS
      IOUT(2)=JQ
      WRITE(NOUT)JS,JF,INRT,"2"
      IF(JS.EQ.0)JS=1
      CALL UNPAC1
      NX=JF-JS+1
      CALL CLUSTA(BUF(1),VM,ND,NX,NVM,NVMMAX,NVG,C,S,RP,R2,NPC,NPT,
     *PLIST,NEC,NET,NMIN,NMC,NMT,IPASS,BUF(IBUF1),
     *BUF(IBUF2),IP,JPTP,RM,RV,VMP,VAR)
      JPTP=JPTP+NX
      DO 403 LL=1,810
      L2=IBUF2+LL-1
      IF(L2.GT.NBUFSZ)GO TO 404
403   IOUT(LL+2)=BUF(L2)
404   CONTINUE
      CALL MTDIO(3,50000K+812,IOUT,IS1,IER)
      GO TO 62
```

```
C
C                 PRINT RESULT SUMMARY
C
   70 WRITE(NOUT,106)
  106 FORMAT(1X,'CLUSTER  SYMBOL  SIZE  R MEAN  R SIGMA  ACRES  ')
      NSAVE=0.0
      DO 72 I=1,NVM
      RV(I)=SQRT(RV(I))
      CC=1.0541515
      IF(NOSCAL.EQ.0) CC=1.53046
      ACRE(I)=NVG(I)*CC
      IF(NVG(I).LT.NSAVE)GO TO 2000
      NSAVE=NVG(I)
      KNUM=I
 2000 CONTINUE
   72 WRITE(NOUT,108)I,CAR(I),NVG(I),RM(I),RV(I),ACRE(I)
  108 FORMAT(I6,7X,A1,F10.0,2X,2F7.2,F10.2)
      I=ND*NVM
      DO 74 J=1,I
   74 VM(J)=VMP(J)
      CALL MTDIO(3,60000K,IOUT,IS1,IER)
      CALL MTDIO(3,60000K,IOUT,IS1,IER)
C
C                 USER OPTION SELECTION
C
   76 WRITE(NOUT,110)
  110 FORMAT(19H CHOOSE OPTION FROM)
      WRITE(NOUT,112) IACOP
  112 FORMAT(1H,4A8)
      READ(NIN,104) IAN
      IF(IAN.EQ.5HMEANS) GO TO 80
      IF(IAN.EQ.6HSIGMAS) GO TO 85
      IF(IAN.EQ.6HANGDIS) GO TO 90
      IF(IAN.EQ.4HQUIT) STOP
      WRITE(NOUT,114) IAN
  114 FORMAT(1H ,A6,22H IS NOT A VALID CHOICE)
      GO TO 76
C
C                 MEANS DISPLAY
C
   80 CALL MATPRT(VM,ND,ND,NVM,5HMEANS)
      GO TO 76
C
C                 SIGMAS DISPLAY
C
   85 I=ND*NVM
      DO 86 J=1,I
   86 VAR(J)=SQRT(VAR(J))
      CALL MATPRT(VAR,ND,ND,NVM,6HSIGMAS)
      GO TO 76
C
C                 ANGDIS DISPLAY
C
   90 IDISF=2
      CALL ANGDIS(VM,NVM,ND,IDISF,AD)
      CALL MATPRT(AD,NVM,NVM,NVM,6HANGDIS)
      GO TO 76
      END
```

```
C***********************************************************************
C                                                                      *
C        PUTIN                                                         *
C                                                                      *
C        INPUT SIGNATURES                                              *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT GEORGIA TECH EES                                   *
C                                                                      *
C        PROGRAMMER:  NICKOLAS L. FAUST                                *
C                                                                      *
C***********************************************************************
      DIMENSION COV(4,4),XM(4)
      CALL OPEN(3,"INSG",0,IE)
      CALL FOPEN(4,"HSIG","B")
      READ(3)NSIG
      ID1=01
      ID2=22
      ID3=77
      IT1=99
      IT2=99
      IT3=99
      WRITE BINARY(4)IT1,IT2,IT3,ID1,ID2,ID3
      DO (L=1,NSIG)
      :  WRITE(10,101)
      :  READ(3,100)NA1,NA2,NA3,NA4
      :  WRITE(10,102)
      :  READ(3)NP
      :  WRITE(10,103)
      :  READ(3)XM
      :  DO (K=1,4)
      :  :  WRITE(10,104)K
      :  :  READ(3)(COV(K,J),J=1,4)
      :  :..FIN
      :  WRITE BINARY(4)NA1,NA2,NA3,NA4
      :  WRITE BINARY(4)NP,XM,COV
      :..FIN
100   FORMAT(4A2)
101   FORMAT(2X,"INPUT NA1,NA2,NA3,NA4")
102   FORMAT(2X,"INPUT NUMBER OF POINTS")
103   FORMAT(2X,"INPUT (XM(I),I=1,4)")
104   FORMAT(2X,"INPUT ROW # ",I1," OF COV - (COV(K,J),J=1,4)")
      STOP
      END
```

```
C*****************************************************************************
C                                                                            *
C       RAINBOW                                                              *
C                                                                            *
C       DISPOSES EXISTING PSEUDOCOLOR MEMORY TO A DISK FILE                  *
C       DISPOSES PSEUDOCOLOR MEMORY IN DISK FILE TO DISPLAY                  *
C                                                                            *
C*****************************************************************************
C                                                                            *
C       CREATED AT GEORGIA TECH EES                                          *
C                                                                            *
C       PROGRAMMER:  FRED L. THOMPSON                                        *
C                                                                            *
C*****************************************************************************
      INTEGER IORAN(94)
      CALL FOPEN (5,"RYGBV.")
      ACCEPT "TYPE 1 TO SAVE PRESENT PSEUDOCOLOR ",IANS1
      IF (IANS1.EQ.1)
      :  REWIND 5
      :  DO (J=1,1000) READ BINARY (5,END=10) IORAN
  10  :  DO (I=1,94) IORAN(I)=0
      :  CALL RCM (0,IORAN)
      :  TYPE "TYPE A 30 CHARACTER DISCREPTION"
      :  TYPE "..............................."
      :  READ (11,20) (IORAN(I),I=65,94)
  20  :  FORMAT (30A1)
      :  WRITE BINARY (5) IORAN
      :  TYPE "PSEUDOCOLOR MEMORY NUMBER ",J
      :..FIN
      ACCEPT "TYPE 1 TO REPLACE PRESENT PSEUDOCOLOR ",IANS2
      IF (IANS2.EQ.1)
      :  ACCEPT "TYPE 1 IF YOU KNOW THE PSEUDOCOLOR MEMORY NUMBER ",IANS3
      :  IF (IANS3.NE.1)
      :  :  PAUSE PUT UP PSEUDOCOLOR TEST PATTERN HIT RETURN
 30   :  :  REWIND 5
      :  :  DO (J=0,1000)
      :  :  :  READ BINARY (5,END=30) IORAN
      :  :  :  WRITE (10,40) (IORAN(I),I=65,94)
  40  :  :  :  FORMAT (1X,30A1)
      :  :  :  CALL WCM (0,IORAN)
      :  :  :  ACCEPT "TYPE 1 FOR NEXT PATTERN ",IANS4
      :  :  :  IF (IANS4.NE.1) STOP NORMAL EXIT
      :  :  :..FIN
      :  :..FIN
      :  IF (IANS3.EQ.1)
      :  :  REWIND 5
      :  :  ACCEPT "PSEUDOCOLOR MEMORY NUMBER ? ",INUM
      :  :  DO (J=1,INUM) READ BINARY (5) IORAN
      :  :  WRITE (10,60) (IORAN(I),I=65,94)
  60  :  :  FORMAT (1X,30A1)
      :  :  CALL WCM (0,IORAN)
      :  :..FIN
      :..FIN
      STOP NORMAL EXIT
      END
```

```
C***********************************************************************
C                                                                      *
C       RATIO                                                          *
C                                                                      *
C       THIS PROGRAM DIVIDES ONE ERTS CHANNEL INTO THE OTHER           *
C       THREE TO LEAVE THREE CHANNELS OF DATA.  IT ALSO WILL TAKE      *
C       TWO CHANNELS AND BY DIVIDING ONE INTO THE OTHER TWO, CREATE    *
C       A THIRD CHANNEL, ALL TO BE DISPLAYED.                          *
C                                                                      *
C       SEQUENCE:  RATIO MTU:F                                         *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT GEORGIA TECH EES                                    *
C                                                                      *
C       PROGRAMMER:  MICHAEL D. FURMAN                                 *
C                                                                      *
C***********************************************************************
      INTEGER INPUT(1700),IMP(3400),IMAG(0:255),IMAG2(0:255),ITAPE(10)
      INTEGER ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,ITAPE,ISW,IERR)
      CALL COMARG(1,ITAPE,ISW,IERR)
      CALL MTOPD(2,ITAPE,0,IE)
      ACCEPT "TWO (2) OR FOUR (4) CHANNEL RATIO ",IANS1
      WHEN (IANS1.EQ.2) ACCEPT "INPUT NUM. AND DENOM. CHANNELS ",INUM,IDEN
      ELSE ACCEPT "INPUT DENOMINATOR CHANNEL ",IDEN
      ACCEPT "SCALE FACTOR ",ISCAL
      ACCEPT "INPUT LINE AND ELEMENT ",LINE,N
      IF (((N/2)*2).EQ.N) N=N-1
      ISKP=1+LINE
      IEL=(N*4)-(6/(1+N-((N/2)*2)))-1
      IEND=IEL+1019
      IDEN2=IDEN*2-1
      DO (I=1,ISKP) CALL MTDIO(2,0,INPUT,IS,IE,IC)
      DO (K2=1,255)
      :  CALL MTDIO(2,0,INPUT,IS,IE,IC)
      :  CALL UPAC8(INPUT,IMP,1700)
      :  M2=0
      :  M1=0
      :  DO (K=1,7,2)
      :  :  L=0
      :  :  IF (K.NE.IDEN2)
      :  :  :  DO (J1=IEL,IEND,8)
      :  :  :  :  IMAG(L)=(IMP(J1+K)/(IMP(IDEN2+J1)+1.0))*ISCAL
      :  :  :  :  IMAG(L+1)=(IMP(J1+K+1)/(IMP(IDEN2+J1+1)+1.0))*ISCAL
      :  :  :  :  L=L+2
      :  :  :  :..FIN
      :  :  :  DO (I=0,255)
      :  :  :  :  IF (IMAG(I).GT.255)
      :  :  :  :  :  TYPE "ATTEMPTED SCALE TO ",IMAG(I)
      :  :  :  :  :  IMAG(I)=255
      :  :  :  :  :..FIN
      :  :  :  :..FIN
      :  :  :  CALL PAC8(IMAG,IMAG2,256)
      :  :  :  CALL RIMWRITE(M1,M2,IMAG2,256)
      :  :  :  WHEN (M2.EQ.0) M2=255
      :  :  :  ELSE M2=0
      :  :  :  M1=M1+1
      :  :  :..FIN
      :  :..FIN
      :..FIN
      STOP
      END
```

```
C***************************************************************************
C                                                                          *
C        RDATA                                                             *
C                                                                          *
C        THIS SUBROUTINE UNPACKS DATA FOR A POLYGON                        *
C                                                                          *
C***************************************************************************
C                                                                          *
C        CREATED AT GEORGIA TECH EES                                       *
C                                                                          *
C        PROGRAMMER:   NICKOLAS L. FAUST                                   *
C                                                                          *
C***************************************************************************
      SUBROUTINE RDATA(ITOP,IBOT,NV,IX,IY,IXD,NP)
      DIMENSION LA(133),IX(101),IY(101),JBUF(100,4),IXD(512,4)
      COMMON /BUFFER/IBUF(1700)
      COMMON/INDEV/IPOS
      IC=0
      ISUM1=ITOP-IPOS-1
222   FORMAT(2X,"SKIPPED ",I5," RECORDS")
      IF(ISUM1.GT.0)CALL MTDIO(2,30000K+ISUM1,IBUF,IS,IER)
      IF(ISUM1.LT.0)CALL MTDIO(2,40000K-ISUM1,IBUF,IS,IER)
      IDEL=IBOT-ITOP+1
      DO  (IL=1,IDEL)
      :   CALL MTDIO(2,0,IBUF,IS,IE)
      :   ISW=ITOP+1
      :   ILIN=ITOP+IL-1
      :   CALL POLY2(ILIN,ISW,IX,IY,NV,LA)
      :   NN=100
      :   NSEG=1
      :   MM=1650
      :   DO  (K=1,NSEG)
      :   :   ISUB1=2*K
      :   :   JS=LA(ISUB1)
      :   :   JF=LA(ISUB1+1)
      :   :   JD=JF-JS+1
      :   :   CALL UNPAC3(IBUF,JBUF,JS,JF,NN,MM)
      :   :   DO  (K=1,JD)
      :   :   :   IC=IC+1
      :   :   :   DO  (KD=1,4)
      :   :   :   :   IXD(IC,KD)=JBUF(K,KD)
      :   :   :   :..FIN
      :   :   :..FIN
      :   :..FIN
      :..FIN
      NP=IC
      IPOS=IBOT
      WRITE(10,222)IDEL
      TYPE "  TOTAL # PTS = ",NP
      RETURN
      END
```

```
C***********************************************************************
C                                                                      *
C       RDIMG   (SUBROUTINE)                                           *
C                                                                      *
C       READ AND DISPLAY IMAGE TO SCREEN                               *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT GEORGIA TECH EES                                    *
C                                                                      *
C       PROGRAMMER:  ROBERT A. MADDOX                                  *
C                                                                      *
C***********************************************************************
      SUBROUTINE RDIMG(IL,IEL,NCH,IBLUP)
      INTEGER IMAG(260),IMAG2(0:512),NCH(0:2)
      COMMON/BUFFER/INPUT(1700),/INDEV/IP0S
      ISUM1=IL-IP0S-1
      IELP=((IEL+254)/2)*4
      IEL2=((IEL-1)/2)*4
      IF (IBLUP.LE.0)
      :  TYPE "ILLEGAL FACTOR",IBLUP
      :  RETURN
      :..FIN
      IF (ISUM1.GT.0) CALL MTDIO(2,30000K+ISUM1,INPUT,IS,IE,IC)
      IF (ISUM1.LT.0) CALL MTDIO(2,40000K-ISUM1,INPUT,IS,IE,IC)
      NCH(0)=1
      ICC=0
      NCH(1)=2
      NCH(2)=4
      M7=255/IBLUP
      DO (K1=0,M7)
      :  CALL MTDIO(2,0,INPUT,IS,IE,IC)
      :  DO (I5=0,2)
      :  :  M5=0
      :  :  IF (I5.EQ.1) M5=255
      :  :  I2=NCH(I5)
      :  :  I3=IEL2+I2
      :  :  I4=IELP+I2
      :  :  L=1
      :  :  DO (J=I3,I4,4)
      :  :  :  JJ=J
      :  :  :  IF(JJ.GT.1700)JJ=1700
      :  :  :  IMAG(L)=INPUT(JJ)
      :  :  :  L=L+1
      :  :  :..FIN
      :  :  IF (IBLUP.GT.1) BLOW-UP-IMAGE
      :  :  DO (I=1,IBLUP)
      :  :  :  ICC=ICC+1
      :  :  :  IF(ICC.GT.768)GO TO 100
      :  :  :  CALL RIMWR(I5,M5,IMAG,256)
      :  :  :..FIN
      :  :..FIN
      :..FIN
100   CONTINUE
      IP0S=IL+M7
      RETURN
      TO BLOW-UP-IMAGE
      :  CALL UPAC8(IMAG,IMAG2,256)
      :  DO (K7=0,255)
      :  :  K9=256-K7
      :  :  KDB=K9/IBLUP
      :  :  IMAG2(K9)=IMAG2(KDB)
      :  :..FIN
      :  CALL PAC8(IMAG2,IMAG,512)
      :..FIN
      END
```

```
C*****************************************************************************
C
C        RETIMG   (SUBROUTINE)
C
C     PURPOSE
C              RETRIEVES IMAGE AND THRESHOLD ARRAYS CORRESPONDING TO
C              A DATA RECORD
C
C     DESCRIPTION OF PARAMETERS
C
C        INPUT
C          CALLING SEQUENCE
C              IFLAG - FIRST ENTRY OR REWIND AND SKIP HEADING RECORD
C                      FLAG
C              NUNIT - UNIT NUMBER
C
C        OUTPUT
C          CALLING SEQUENCE
C              IMG - IMAGE ARRAY
C              THR - CORRESPONDING THRESHOLD ARRAY
C              NP - NUMBER OF POINTS IN EACH ARRAY
C
C*****************************************************************************
C
C        CREATED AT NASA/JSC   (ASTEP)
C
C*****************************************************************************
      SUBROUTINE RETIMG(IFLAG,NUNIT,IMG,THR,NP)
      DIMENSION IMG(112)
      COMMON/COL/JS,JF
      INTEGER THR
      IF(IFLAG.NE.1) GO TO 10
      REWIND NUNIT
10    READ BINARY(NUNIT)JS,NP,(IMG(I),I=1,NP)
      RETURN
      END
```

```
C*****************************************************************************
C                                                                            *
C        SAVIMG   (SUBROUTINE)                                               *
C                                                                            *
C     PURPOSE                                                                *
C              SAVES, ON TAPE, IMAGE AND THRESHOLD ARRAYS CORRESPONDING      *
C              TO A DATA RECORD                                              *
C                                                                            *
C     DESCRIPTION OF PARAMETERS                                              *
C                                                                            *
C         INPUT                                                              *
C           CALLING SEQUENCE                                                 *
C              IFLAG - FIRST ENTRY OR REWIND AND WRITE HEADING RECORD        *
C                      FLAG                                                  *
C              NUNIT - UNIT NUMBER                                           *
C              IMG - IMAGE ARRAY TO BE SAVED                                 *
C              THR - THRESHOLD ARRAY CORRESPONDING TO IMG                    *
C              NP - NUMBER OF POINTS IN EACH ARRAY                           *
C                                                                            *
C*****************************************************************************
C                                                                            *
C        CREATED AT NASA/JSC   (ASTEP)                                       *
C                                                                            *
C*****************************************************************************
      SUBROUTINE SAVIMG(IFLAG,NUNIT,IMG,THR,NP)
      DIMENSION IMG(NP),THR(NP)
      INTEGER THR
      DIMENSION BLK(166)
      COMMON/COL/JS,JF
      BLK(1)=1.
      IF(IFLAG.NE.1) GO TO 10
      REWIND NUNIT
10    WRITE BINARY(NUNIT)JS,NP,(IMG(K),K=1,NP)
      WRITE(12)NP,IMG(1)
      RETURN
      END
```

```
C*****************************************************************************
C
C        SCORECARD
C
C        THIS ROUTINE CLASSIFIES TRAINING FIELDS WITH A
C        MAXLIK CLASSIFIER
C
C        SEQUENCE:  SCORECARD INPUT TAPNAM SIGFIL VERTEX
C
C*****************************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:  NICHOLAS L. FAUST
C
C*****************************************************************************
      DIMENSION AMEAN(4,20),BCOV(4,4,20),IVX(101),IVY(101),B(400),DET(20
     1,LA(133),NVG(20),ICOUNT(20),IBUF(1650),I1(30),I2(30),I3(30),I4(30)
     2,IORDER(20),NAM1(20),NAM2(20),NAM3(20),NAM4(20),ISW(2)
      COMMON/DTRANS/IDAT(256),JBUF(512,4),IDUM(512)
      IP=12
C
C         FIELD AND OPEN STATEMENTS
C
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I1,ISW,IERR)
      CALL COMARG(1,I2,ISW,IERR)
      CALL COMARG(1,I3,ISW,IERR)
      CALL COMARG(1,I4,ISW,IERR)
C
      CALL OPEN(2,I1,0,IE)
      CALL FOPEN(7,"MAXFLD","B")
C
C         OPEN TAPE FILE
C
      CALL MTOPD(3,I2,0,IE)
      ND=4
      NUN1=2
      NUN2=4
      READ(2,200)NSIG
      WRITE(IP)NSIG
C
C         GET SIGNATURES  FOR CLASSIFICATION
C
      CALL GSIG(AMEAN,BCOV,NSIG,NUN1,NUN2,I3,IORDER,NAM1,NAM2,NAM3,NAM4)
      CALL ICD(AMEAN,BCOV,ND,NSIG,DET,B,B)
C
C
      ISIG=0
```

```
      DO (KSIG=1,NSIG)
      :   ISIG=ISIG+1
      :   CALL FOPEN(5,I4,"B")
      :   READ BINARY(5)ITAP1,ITAP2,ITAP3,IDAT1,IDAT2,IDAT3
      :   K3=IORDER(KSIG)
      :   DO (K2=1,K3)
      :   :   READ BINARY(5)NA1,NA2,NA3,NA4
      :   :   READ BINARY(5)K,IYMIN,IYMAX
      :   :   DO (I=1,K)
      :   :   :   READ BINARY(5)K1,IVX(I),IVY(I)
      :   :   :..FIN
      :   :..FIN
      :   CALL FCLOSE(5)
      :   WRITE(IP)ITAP1,ITAP2,ITAP3
      :   WRITE(IP)IDAT1,IDAT2,IDAT3
      :   WRITE(IP,103)NA1,NA2,NA3,NA4
      :   WRITE(IP)K,IYMIN,IYMAX
      :   DO (L3=1,K)
      :   :   WRITE(IP)K1,IVX(L3),IVY(L3)
      :   :..FIN
      :   NV=K
      :   ISKIP=IYMIN+1
      :   IVX(K+1)=IVX(1)
      :   IVY(K+1)=IVY(1)
      :   IDEL=IYMAX-IYMIN+1
      :   DO (II=1,20)
      :   :   ICOUNT(II)=0
      :   :..FIN
      :   JTOT=0
C     :
      :
C     :   /*SKIP RECORDS
C     :
      :   CALL MTDIO(3,30000K+ISKIP,IBUF,IS,IEE)
      :   WRITE BINARY(7)IDEL,ISIG
      :   DO (J=1,IDEL)
      :   :   CALL MTDIO(3,0,IBUF,IS,IE,NW)
      :   :   ISW=2
      :   :   CALL POLY2(ISKIP+J-1,ISW,IVX,IVY,NV,LA)
      :   :   JS=LA(2)
      :   :   JF=LA(3)
      :   :   CALL UNPAC3(IBUF,JBUF,JS,JF,512,1650)
      :   :   JQ=JF-JS+1
      :   :   WRITE(IP)J,JS,JF,JQ,IDEL,ISKIP
      :   :   DO (L=1,JQ)
      :   :   :   DO (L1=1,ND)
      :   :   :   :   ISUB=(L-1)*ND+L1
      :   :   :   :   IBUF(ISUB)=JBUF(L,L1)
      :   :   :   :..FIN
      :   :   :..FIN
C     :   :
C     :   :
C     :   :
      :   :   CALL MAXLI(IBUF,ND,JQ,AMEAN,BCOV,NSIG,DET,IDUM,NVG)
C     :   :
C     :   :
C     :   :
      :   :   JMOVE=JS-1
      :   :   WRITE  BINARY(7)JMOVE,JQ,IDUM
      :   :   JTOT=JTOT+JQ
      :   :   DO  (K=1,JQ)
      :   :   :   LSUB=IDUM(K)
      :   :   :   ICOUNT(LSUB)=ICOUNT(LSUB)+1
      :   :   :..FIN
      :   :..FIN
      :   DO (K=1,NSIG)
      :   :   JPER=(ICOUNT(K)*100)/JTOT
      :   :   WRITE(12,102)K,ICOUNT(K),JPER,NAM1(K),NAM2(K),NAM3(K),NAM4(K)
      :   :..FIN
      :   ISUM=IDEL+ISKIP
      :   CALL MTDIO(3,40000K+ISUM,IBUF,IS,IER)
      :..FIN
102   FORMAT(2X,"CLASS    ",I4,"  NUMBER   ",I6,"  PERCENT   ",I3,2X,4A2)
103   FORMAT(2X,4A2)
200   FORMAT(I2)
      STOP
      END
```

```
C*****************************************************************************
C
C        SEQCOV   (SUBROUTINE)
C
C      PURPOSE
C
C       RECURSIVE CALCULATION OF SAMPLE COVARIANCE MATRICIES AND
C       MEAN VECTORS
C
C        INPUT
C
C             CALLING SEQUENCE
C                 X = CURRENT SAMPLE VECTOR
C                 N = DIMENSION OF X
C                 V = PREVIOUS COVARIANCE MATRIX
C                 M = PREVIOUS MEAN VECTOR
C                 I = PREVIOUS # OF SAMPLES
C                 D = SCRATCH AREA
C
C       OUTPUT
C
C                 V = CURRENT COVARIANCE MATRIX
C                 M = CURRENT MEAN VECTOR
C                 I = CURRENT # OF SAMPLES
C
C*****************************************************************************
C
C        CREATED AT NASA/JSC   (ASTEP)
C
C*****************************************************************************
      SUBROUTINE SEQCOV(X,N,V,M,I,D)
      INTEGER X
      DIMENSION X(N)
      DIMENSION V(N,N)
      REAL M(N)
      DIMENSION D(N,2)
      WHEN(I.LE.0)
      :  DO  (L=1,N)
      :  :  V(K,L)=0.0
      :  :  I=1
      :  :  RETURN
      :  :..FIN
      :..FIN
      ELSE
      :  FI=FLOAT(I)
      :  FIP=1./FI
      :  I=I+1
      :  FI=FLOAT(I)
      :  FI=1./FI
      :  DO  (K=1,N)
      :  :  D(K,1)=X(K)-M(K)
      :  :  D(K,2)=D(K,1)*FI
      :  :  M(K)=M(K)+D(K,2)
      :  :..FIN
      :  FIP=1.-FIP
      :  DO  (K=1,N)
      :  :  DO  (L=1,N)
      :  :  :  V(K,L)=FIP*V(K,L)+D(K,2)*D(L,1)
      :  :  :..FIN
      :  :..FIN
      :..FIN
      RETURN
      END
```

```
C*****************************************************************************
C                                                                            *
C        SEQST   (SUBROUTINE)                                                *
C                                                                            *
C     PURPOSE                                                                *
C              SEQUENTIALLY CALCULATED MEAN VECTOR AND VARIANCES             *
C                                                                            *
C     DESCRIPTION OF PARAMETERS                                              *
C                                                                            *
C        INPUT                                                               *
C          CALLING SEQUENCE                                                  *
C              XM - CURRENT MEAN                                             *
C              XV - CURRENT VARIANCES                                        *
C              N - NUMBER OF POINTS USED TO COMPUTE XM AND XV                *
C              ND - DIMENSION OF DATA VECTOR                                 *
C              X - NEW DATA VECTOR TO BE ADDED TO XM AND XV                  *
C                                                                            *
C        OUTPUT                                                              *
C          CALLING SEQUENCE                                                  *
C              XM,XV,N - UPDATED VALUES                                      *
C                                                                            *
C*****************************************************************************
C                                                                            *
C        CREATED AT NASA/JSC   (ASTEP)                                       *
C                                                                            *
C*****************************************************************************
      SUBROUTINE SEQST(XM,XV,N,ND,X)
      DIMENSION XM(ND),XV(ND),X(ND)
      INTEGER X
      IF(N.GT.0) GO TO 20
      DO 10 I=1,ND
      XM(I)=X(I)
   10 XV(I)=0.
      N=1
      RETURN
   20 F1=(1.-1./FLOAT(N))
      N=N+1
      F2=1./FLOAT(N)
      DO 30 I=1,ND
      T=X(I)-XM(I)
      XM(I)=XM(I)+F2*T
   30 XV(I)=F1*XV(I)+F2*(T**2)
      RETURN
      END
```

```
C****************************************************************************
C
C         STRIPLESS
C
C         PROGRAM TO DESTRIPE A DATA SET GIVEN THE
C         CONVERSION TABLE FROM STRNF2
C
C         SEQUENCE:  STRIPLESS MTIN:F MTOUT:F TABLE
C
C****************************************************************************
C
C        PROGRAMMERS:  RONNIE PIERSON (NASA/ERL)
C                      NICKOLAS FAUST (GEORGIA TECH EES)
C
C****************************************************************************
      DIMENSION IEM(4000),LT(4,6,128),IZ(2,4,412)
      DIMENSION ITAP(15),JTAP(15),IFIL(15),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,ITAP,ISW,IERR)
      CALL COMARG(1,ITAP,ISW,IERR)
      CALL COMARG(1,JTAP,ISW,IERR)
      CALL COMARG(1,IFIL,ISW,IERR)
      CALL FOPEN(3,IFIL,"B")
      CALL MTOPD(2,ITAP,0,IERR)
      CALL MTOPD(4,JTAP,0,IERR)
      NOFT1=1
      READ BINARY(3)LT
      DO (K=1,2)
      :  CALL MTDIO(2,0,IEM,IS,IERR,NW)
      :  CALL MTDIO(4,50000K+NW,IEM,IS,IERR)
      :..FIN
      N=0
      NL=0
      TYPE "HOW MANY LINES OF 6 TO SKIP?"
      READ(11)KICK
      TYPE "HOW MANY LINES TO PROCESS?"
      READ(11)NLINE
      KICK6=6*KICK
      IF(KICK.GT.0)
      :  CALL MTDIO(2,30000K+KICK6,IEM,IS,IERR)
      :..FIN
      FOREVER
      :  CALL MTDIO(2,0,IEM,IS,IERR,NW)
      :  N=N+1
      :  NL=NL+1
      :  IF(NL .GT. NLINE)WRITE-EOF
      :  IF(NW .LE. 50)WRITE-EOF
      :  CALL PACKER(1,IEM,IZ)
      :  DO (I=1,4)
      :  :  DO (J=1,407)
      :  :  :  K=IZ(1,I,J)+1
      :  :  :  K1=IZ(2,I,J)+1
      :  :  :  IF(K .GT. 128)K=128
      :  :  :  IF(K1 .GT. 128)K1=128
      :  :  :  IZ(2,I,J)=LT(I,N,K1)
      :  :  :  IZ(1,I,J)=LT(I,N,K)
      :  :  :..FIN
      :  :..FIN
      :  CALL PACKER(2,IEM,IZ)
      :  CALL MTDIO(4,50000K+1650,IEM,IS,IERR)
      :  IF(N .EQ. 6)N=0
      :..FIN
      TO WRITE-EOF
      :  CALL MTDIO(4,60000K,IEM,IS,IERR)
      :  CALL MTDIO(4,60000K,IEM,IS,IERR)
      :  CALL MTDIO(4,10000K,IEM,IS,IERR)
      :  CALL MTDIO(2,10000K,IEM,IS,IERR)
      :  STOP
      :..FIN
      END
```

```
C***********************************************************************
C                                                                      *
C       STRIPNF                                                        *
C                                                                      *
C       TO ELIMINATE STRIPING IN LANDSAT DATA                          *
C                                                                      *
C       SEQUENCE:  STRNF2 TAPE TABFIL                                  *
C                                                                      *
C***********************************************************************
C                                                                      *
C       CREATED AT NASA/ERL                                            *
C                                                                      *
C       PROGRAMMER:  RON PIERSON                                       *
C                                                                      *
C***********************************************************************
      DIMENSION IER(620,8),LT(4,6,128),IUNPAK(2,4,3),DT(4,8,129)
      DIMENSION IEM(1650),LIMS(4,6,2)
      DIMENSION ITAP1(15),ITAB(15)
      COMMON/DUM/IER,DT,LIMS,IUNPAK,ITAP1
      EQUIVALENCE (IEM(1),IER(1,6))
      EQUIVALENCE (LT(1,1,1),IER(1,1))
      CALL FIELD(2,ITAP1,$701)
      CALL FIELD(3,ITAB,$701)
      CALL MTOPD(1,ITAP1,0,IERR)
      CALL FOPEN(3,ITAB,"B")
      NOFTR=0
      NL1=0
      NOFT1=1
      NOFT=1
      WRITE(10,2222)
2222  FORMAT(2X,"INPUT NPRNT NLINES")
      READ(11)NPRNT,NLINES
99    CALL MTDIO(1,0,IEM,IS,IERR)
      CALL MTDIO(1,0,IEM,IS,IERR)
C       SIX SCAN READ
10    N=1
      IERROR=0
11    CALL MTDIO(1,0,IEM,IS,IERR,NW)
      IF(NW.LT.1600)GO TO 400
      IF(NL1.GT.NLINES)GO TO 400
      DO (KV=1,620)IER(KV,N)=IEM(KV)
      N=N+1
      NL1=NL1+1
      IF(N.LT.7)GO TO 11
C       SIX BY SIX PROCESS
      N=1
      NUM=0
      DO 299 NE=1,51
      N=N+12
      DO 280 J=1,6
      DO (L1=1,3)
      :  DO (L2=1,4)
      :  :  N1=N+(L1-1)*4+L2-1
      :  :  IWRD=IER(N1,J)
      :  :  IUNPAK(1,L2,L1)=ISHFT(IWRD,-8)
      :  :  IUNPAK(2,L2,L1)=IAND(IWRD,377K)
      :  :..FIN
      :..FIN
C       ELEMENT AVERAGE
      DO 280 I=1,4
      DO 200 K1=1,3
      NUM=NUM+IUNPAK(1,I,K1)+IUNPAK(2,I,K1)
200   CONTINUE
      DT(I,J,1)=FLOAT(NUM)/6.
      NUM=0
280   CONTINUE
      DO 284 I=1,4
C       DISCARD OF ABNORMAL DATA VALUES
      SM=DT(I,1,1)
      BG=SM
```

```
      DO 279 J=2,6
      RAD=DT(I,J,1)
      IF(RAD.GT.SM)GO TO 275
      SM=RAD
      GO TO 279
275   IF(RAD.LT.BG)GO TO 279
      BG=RAD
279   CONTINUE
      RAD=BG-SM
      IF(RAD.GT.10.)GO TO 284
C       DATA AGREGATION
      AVG=0.
      DO 282 J=1,6
282   AVG=DT(I,J,1)+AVG
      MN=AVG/6.+.5
      IF(MN.LT.0)GO TO 284
      IF(MN.GT.127)GO TO 284
      MN=MN+2
      D=DT(I,7,MN)+6.
      DO 283 J=1,6
      DT(I,J,MN)=(DT(I,J,MN)*DT(I,7,MN)+6.*DT(I,J,1))/D
283   CONTINUE
C       POINT TOTAL UPDATE
      DT(I,7,MN)=D
284   CONTINUE
299   CONTINUE
      GO TO 10
400   NOFTR=NOFTR+1
      IF(NOFTR.LT.NOFT)GO TO 99
C       DETERMINATION OF USEABLE DATA RANGES
      DO 1099 I=1,4
      J=2
1013  J=J+1
      IF(DT(I,7,J).LT.299.)GO TO 1013
      IER(I,6)=J
      J=125
1017  J=J-1
      IF(DT(I,7,J).LT.299.)GO TO 1017
1099  IER(I+4,6)=J
C       MEAN ADJUST
      DO 410 I=1,4
      L1=IER(I,6)
      K1=IER(I+4,6)
      DO 410 NE=L1,K1
      SUM=0.
      DO 405 J=1,6
405   SUM=SUM+DT(I,J,NE)
      AVG=SUM/6.
      A=0.
      L=1
      K=3
      DO 406 J=1,6
      B=DT(I,J,NE)-AVG
      IF(B.LT.0)B=-B
      IF(B.LT.A)GO TO 406
      A=B
      L=J
406   CONTINUE
      SUM=SUM-DT(I,L,NE)
      AVG=SUM/5.
      IF(L.EQ.K)K=1
      A=0.
      DO 407 J=1,6
      IF(J.EQ.L)GO TO 407
      B=DT(I,J,NE)-AVG
      IF(B.LT.0.)B=-B
      IF(B.LT.A)GO TO 407
      A=B
      K=J
407   CONTINUE
```

```
      SUM=SUM-DT(I,K,NE)
410   DT(I,8,NE)=SUM/4.
C       SMOOTHING OF SPARSE DATA OVER USEABLE DATA RANGES
      DO 1199 I=1,4
      J=IER(I,6)+1
      K=IER(I+4,6)-1
      DO 1199 L=J,K
      IF(DT(I,7,L).GT.299.)GO TO 1199
      N=L
1113  N=N-1
      IF(DT(I,7,N).LT.299.)GO TO 1113
      M=L
1117  M=M+1
      IF(DT(I,7,M).LT.299.)GO TO 1117
      RAD=DT(I,7,L)/300.
      SM=1.-RAD
      IF(DT(I,7,L).LT.10.)DT(I,8,L)=FLOAT(L-2)
      A=(DT(I,8,L)-DT(I,8,N))/(DT(I,8,M)-DT(I,8,N))
      DO 1121 L1=1,6
      BG=DT(I,L1,M)-DT(I,L1,N)
      BG=A*BG+DT(I,L1,N)
1121  DT(I,L1,L)=SM*BG+RAD*DT(I,L1,L)
1199  CONTINUE
      IF(NPRNT.EQ.0)GO TO 500
      DO 499 NE=2,63
      MN=NE-2
      WRITE(12,401)MN
401   FORMAT(9X,"BAND 1",6X,"BAND 2",6X,"BAND 3",6X,"BAND 4",6X,"MEAN",I2)
      DO 404 J=1,8
      A=DT(1,J,NE)
      B=DT(2,J,NE)
      C=DT(3,J,NE)
      D=DT(4,J,NE)
      WRITE(12,402)J,A,B,C,D
402   FORMAT(2X,"DET",1X,I1,4(3X,F9.2))
404   CONTINUE
499   CONTINUE
C       MID-RANGE TABLE BUILDER
500   DO 498 I=1,4
      DO 498 NE=1,6
      L=IER(I,6)
      K=IER(I+4,6)
      SM=DT(I,NE,L)
      K=DT(I,NE,K)
      J=SM
      A=FLOAT(J)
      IF(SM.NE.A)J=J+1
      LIMS(I,NE,1)=J
      LIMS(I,NE,2)=K+2
      DO 498 M=J,K
      A=FLOAT(M)
      N=M+1
431   IF(DT(I,NE,L).LE.A)GO TO 435
      L=L-1
      GO TO 431
435   L2=L+1
      IF(DT(I,NE,L2).GT.A)GO TO 441
      L=L+1
      GO TO 431
441   A2=DT(I,NE,L2)-DT(I,NE,L)
      B=A-DT(I,NE,L)
      B2=DT(I,8,L2)-DT(I,8,L)
      LT(I,NE,N)=DT(I,8,L)+B*B2/A2+.5
498   L=L+1
```

```
C         BELOW-RANGE TABLE BUILDER
      DO 415  I=1,4
      DO 415  NE=1,6
      K=LIMS(I,NE,1)
      L=K
      DO 415  J=1,K
      M=LT(I,NE,L+1)-1
      IF(M.LT.0)M=0
      LT(I,NE,L)=M
415   L=L-1
C         ABOVE-RANGE TABLE BUILDER
      DO 425  I=1,4
      DO 425  NE=1,6
      K=LIMS(I,NE,2)
      DO 425  L=K,128
      M=LT(I,NE,L-1)+1
      IF(M.GT.127)M=127
425   LT(I,NE,L)=M
C         TABLE SMOOTHER
      DO 525  I=1,4
      DO 525  J=1,6
      DO 525  K=2,126
      M=K+1
      L=LT(I,J,M)-1
      IF(L.LE.LT(I,J,K))GO TO 525
      N=K-1
      IF(LT(I,J,N).LT.LT(I,J,K))GO TO 521
      LT(I,J,K)=LT(I,J,K)+1
      GO TO 525
521   L=K+2
      IF(LT(I,J,L).GT.LT(I,J,M))GO TO 525
      LT(I,J,M)=LT(I,J,M)-1
525   CONTINUE
      DO 541  I=1,4
      DO 541  J=1,6
541   LT(I,J,1)=0
      IF(NPRNT.EQ.0)GO TO 550
      DO 549  K=1,128
      MN=K-1
      WRITE(12,601)MN
601   FORMAT(6X,"CHNL 1   CHNL 2   CHNL 3   CHNL 4     INPUT=",I3)
      DO 549  J=1,6
      L=LT(1,J,K)
      L2=LT(2,J,K)
      M=LT(3,J,K)
      N=LT(4,J,K)
      WRITE(12,603)J,L,L2,M,N
603   FORMAT(2X," DET ",I1,3X,4(I3,6X))
549   CONTINUE
C
C        DATA CORRECTION
C
550   CONTINUE
      WRITE BINARY(3) LT
      CALL FCLOSE(3)
      CALL MTDIO(1,10000K,IEM,IS,IERR)
666   STOP
701   STOP STRNF2 TAPE TABFIL
      END
```

```
C*************************************************************************
C                                                                        *
C        SUMCAT                                                          *
C                                                                        *
C        THIS ROUTINE SUMS CLASSIFIED CATEGORIES INTO                    *
C        GENERAL CATEGORIES FOR OUTPUT                                   *
C                                                                        *
C        SEQUENCE: SUMCAT INFIL                                          *
C                                                                        *
C*************************************************************************
C                                                                        *
C        CREATED AT GEORGIA TECH EES                                     *
C                                                                        *
C        PROGRAMMER:  NICKOLAS FAUST                                     *
C                                                                        *
C*************************************************************************
      DIMENSION COUNT(60),IEQ(60,20),NUM(20),ICAR(10,20)
      DIMENSION JFIL(34),LSUM(20),PER(60),KFIL(34),ISWS(2)
      CALL OPEN(1,"COM.CM",1,IE)
      CALL COMARG(1,JFIL,ISWS,IE)
      CALL COMARG(1,JFIL,ISWS,IE)
      CALL OPEN(3,JFIL,"B")
      CALL COMARG(1,KFIL,ISWS,IE)
      CALL FOPEN(2,KFIL,"B")
      READ(3)ISUM
      DO (L=1,ISUM)
      :   READ (3,101) (ICAR(J,L),J=1,10)
101   :   FORMAT (10A2)
      :   READ(3)NUM(L)
      :   NUM2=NUM(L)
      :   READ(3)(IEQ(J,L),J=1,NUM2)
      :..FIN
      READ(3)NWQ
      DO (K=1,NWQ)
      :   STOT=0.
      :   DO (KG=1,60)COUNT(KG)=0.
      :   READ(2,130)NA1
130   :   FORMAT(I4)
      :   WRITE(12,131)NA1
131   :   FORMAT(2X,"    WQMU #    ",I5///)
      :   DO (KZ=1,60)
      :   :   READ(2,70)COUNT(KZ),PER(KZ)
70    :   :   FORMAT(2X,F12.2,2X,F12.2)
      :   :   WRITE(10)COUNT(KZ),PER(KZ)
      :   :..FIN
      :   DO (N=1,ISUM)
      :   :   NUM2=NUM(N)
      :   :   S2=0
      :   :   S1=0
      :   :   DO (L=1,NUM2)
      :   :   :   IQ=IEQ(L,N)
      :   :   :   S1=S1+COUNT(IQ)
      :   :   :   S2=S2+PER(IQ)
      :   :   :..FIN
      :   :   WRITE(12,102)N,(ICAR(J,N),J=1,10),S1,S2
      :   :   STOT=STOT+S1
102   :   :   FORMAT(2X,I2,2X,10A2,2X,F10.1,"     ACRES",2X,F6.3,"     PERCEN
      :   :..FIN
      :   WRITE(12,103)STOT
103   :   FORMAT(/6X,"TOTAL       ",10X,F12.1,"     ACRES")
      :   WRITE(12,200)
200   :   FORMAT(/////////////)
      :..FIN
      STOP
      END
```

```
C*****************************************************************************
C
C       SYMINV  (SUBROUTINE)
C
C       INVERTS A SYMMETRIC MATRIX
C
C*****************************************************************************
C
C       CREATED AT NASA JSC
C
C*****************************************************************************
        SUBROUTINE SYMINV(A,AI,DET,N)
        DIMENSION A(N,N),AI(N,N),QC(12),D(12),DI(12)
        INTEGER R
        DET=1.0
        R=0
10      R=R+1
        IF(R.GT.N)GO TO 19
        QC(R)=1.0
        I=0
20      I=I+1
        IF(I.GT.R-1)GO TO 29
        QC(I)=0.0
        J=0
30      J=J+1
        IF(J.GT.R-1)GO TO 20
        QC(I)=QC(I)-AI(I,J)*A(J,R)
        GO TO 30
29      CONTINUE
        D(R)=A(R,R)
        IF(D(R).LE.0.0)GO TO 52
        K=0
40      K=K+1
        IF(K.GT.R-1)GO TO 49
        D(R)=D(R)+A(R,K)*QC(K)
        GO TO 40
49      CONTINUE
        DET=DET*D(R)
        IF((D(R)/A(R,R)).LT.1.E-8)GO TO 52
51      DI(R)=1.0/D(R)
        GO TO 60
52      DI(R)=0.0
        WRITE(12,1010)R,D(R),DET
1010    FORMAT(9H AT STEP ,I1,4H D =,E10.5,6H DET =,E10.5)
60      I=0
70      CONTINUE
        I=I+1
        IF(I.GT.R)GO TO 100
        AI(R,I)=0.0
        AI(I,R)=0.0
        J=0
80      J=J+1
        IF(J.GT.R)GO TO 70
        QD=QC(I)*DI(R)
        AI(I,J)=AI(I,J)+QD*QC(J)
        GO TO 80
100     CONTINUE
        GO TO 10
19      CONTINUE
        RETURN
        END
```

```
C***********************************************************************
C                                                                      *
C        THRDST   (SUBROUTINE)                                         *
C                                                                      *
C     PURPOSE                                                          *
C              UPDATE THE MEAN AND VARIANCE OF THE THRESHOLD STATISTICS *
C                                                                      *
C     DESCRIPTION OF PARAMETERS                                        *
C                                                                      *
C        INPUT                                                         *
C          CALLING SEQUENCE                                            *
C              X1,V1,N1 - CURRENT MEAN, VARIANCE, AND WEIGHT           *
C              X2,N2 - VALUE AND WEIGHT OF NEW SAMPLES                 *
C                                                                      *
C        OUTPUT                                                        *
C          CALLING SEQUENCE                                            *
C              X1,V1 - UPDATED VALUES                                  *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT NASA/JSC   (ASTEP)                                 *
C                                                                      *
C***********************************************************************
      SUBROUTINE THRDST(X1,V1,N1,X2,N2)
      REAL N1
      IF(N1.GT.0.) GO TO 10
      X1=X2
      V1=0.
      RETURN
   10 X=(N1+FLOAT(N2))
      R1=(N1)/X
      R2=FLOAT(N2)/X
      X=R1*X1+R2*X2
      V1=R1*(V1+X1**2)+R2*(X2**2)-X**2
      X1=X
      RETURN
      END
```

```
C*****************************************************************************
C
C        TOPO2
C
C        READS CYBER CONVERTED TOPO TAPES AND
C        DISPLAYS THEM TO THE COMTAL.
C
C        SEQUENCE:  TOPO2 MTU:F
C
C*****************************************************************************
C
C        CREATED AT GEORGIA TECH EES
C
C        PROGRAMMER:  MICHAEL D. FURMAN
C
C*****************************************************************************
      INTEGER IMP(1810),IWORK(512),IMAG(256),ITAPE(10),ISW(2)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,ITAPE,ISW,IERR)
      CALL COMARG(1,ITAPE,ISW,IERR)
      ACCEPT "FAST SCAN? (1=YES,0=NO) ",IFSCAN
      WHEN (IFSCAN.EQ.1) IFSCAN=4
      ELSE IFSCAN=1
      ACCEPT "SKIP RECORDS? ",ISKP
      ACCEPT "MAX ACCEPTED PEAK VALUE (AFTER SUBTRACTION) ",IPEAK
      P2=IPEAK/255.0
      ACCEPT "ASSIGNED PEAK SHADE VALUE? ",ISHADE
      ACCEPT "SUBTRACT WHAT VALUE FROM ALL DATA? ",ISUB
      ACCEPT "BEGIN WITH ELEMENT? ",IEL
      IEL=IEL+7
      IEND=IEL+511
      IF (IFSCAN.EQ.4) IEND=1800
      IF (IEND.GT.1800) IEND=1800
      CALL MTOPD(3,ITAPE,0,IE)
      LINE=ISKP
      DO (I=1,ISKP) CALL MTDIO(3,0,IMP,IS,IE,IC)
      DO (M5=1,256)
      :  TYPE "LINE NUMBER ",LINE
      :  LINE=LINE+IFSCAN
      :  DO (I=1,IFSCAN) CALL MTDIO(3,0,IMP,IS,IE,IC)
      :  K=1
      :  DO (I=IEL,IEND,IFSCAN)
      :  :  IWORK(K)=IMP(I)
      :  :  K=K+1
      :  :..FIN
      :  K2=K-1
      :  SUBTRACT-CONSTANT-AND-CUT-OFF-PEAKS
      :  CALL PAC8(IWORK,IMAG,512)
      :  CALL RIMWRITE(0,0,IMAG,256)
      :  IF (M5.EQ.256) ACCEPT "TYPE A '1' TO CONTINUE ",IANS
      :  IF (IANS.EQ.1) M5=1
      :..FIN
      STOP
      TO SUBTRACT-CONSTANT-AND-CUT-OFF-PEAKS
      :  DO (M6=1,K2)
      :  :  WHEN (IWORK(M6).LT.ISUB) IWORK(M6)=0
      :  :  ELSE IWORK(M6)=IWORK(M6)-ISUB
      :  :  IF (IWORK(M6).GT.IPEAK) IWORK(M6)=IPEAK
      :  :  IWORK(M6)=IWORK(M6)/P2
      :  :..FIN
      :..FIN
      END
```

```
C***************************************************************************
C                                                                          *
C                                                                          *
C       TRAIN3                                                             *
C                                                                          *
C       THIS PROGRAM IS DESIGNED FOR TRAINING FIELD SELECTION              *
C       AND STATISTICS GENERATION FOR THREE IMAGES                         *
C                                                                          *
C       SEQUENCE:  TRAIN3 MTU:F                                            *
C                                                                          *
C***************************************************************************
C                                                                          *
C       DESIGNED AT GEORGIA TECH EES                                       *
C                                                                          *
C       PROGRAMMERS:  NICKOLAS L. FAUST                                    *
C                     ROBERT A. MADDOX                                     *
C                     MICHAEL D. FURMAN                                    *
C                                                                          *
C***************************************************************************
      DIMENSION V(4,4),XM(4),IV(101),IVX(101),IVY(101)
      DIMENSION D(4,2),MX(4),IDEV(30)
      INTEGER FIELD(17),ISWS(2)
      COMMON /DTRANS/ IDAT(256),IXD(512,4),IDUM(512)
      COMMON /HISTX/ ICOUNT(4,100)
      COMMON /BUFFER/ IBUF(1700)
C
C
C
      OPEN-FILES
      INIT-VARIABLES
      FOREVER
      :  ASK-QUESTIONS
      :  CONDITIONAL
      :  :  (IFUN.EQ.1) READ-IMAGE
      :  :  (IFUN.EQ.2) ALARM-SCREEN
      :  :  (IFUN.EQ.3) MAGNIFY-SUBSET-OF-SCREEN
      :  :  (IFUN.EQ.4) TAKE-TRAINING-SAMPLE
      :  :  (IFUN.EQ.5) TAKE-GCP
      :  :  (IFUN.EQ.6) DIGITIZE-BOUNDARY
      :  :  (IFUN.EQ.7) CALL FSWAP("SCRIPTO.SV")
      :  :  (IFUN.EQ.8) CALL FSWAP("INK.SV")
      :  :  (IFUN.EQ.9) CALL FSWAP("WFMBOB.SV")
      :  :  (IFUN.EQ.10) CALL FSWAP("CHCOLR.SV")
      :  :  (IFUN.EQ.11) CALL FSWAP("FILTER2.SV")
      :  :  (IFUN.EQ.12) CALL FSWAP("CLYDE5.SV")
      :  :  (IFUN.EQ.98) BLANK-GRAPHICS
      :  :  (IFUN.EQ.99) CLOSE-FILES
      :  :  (OTHERWISE)
      :  :  :  TYPE "PLEASE ENTER ONE OF THE NUMBERS GIVEN"
      :  :  :..FIN
      :  :..FIN
      :..FIN
C
C
      TO OPEN-FILES
      :  CALL OPEN(1,"COM.CM",1,IFER)
      :  CALL COMARG(1,FIELD,ISWS,IFER)
      :  CALL COMARG(1,FIELD,ISWS,IFER)
      :  IF (FIELD(1).NE."MT")
      :  :  TYPE "PARAMETER ERROR   TRAIN3 MTU:F"
      :  :  TYPE "TAPE NAME PROBABLY NOT ENTERED"
      :  :  STOP PARAMETER ERROR IN TRAIN3 MTU:F  ERROR HALT
      :  :..FIN
      :  CALL MTOPD(2,FIELD,0,IFER)
      :  CALL FOPEN(3,"VERTEX","B")
      :  CALL FOPEN(4,"HISTS","B")
      :  CALL FOPEN(5,"SAVSIG","B")
      :  TYPE "INPUT TAPE NUMBER IN 6I2 FORMAT "
      :  READ(11,96) IT1,IT2,IT3,ID1,ID2,ID3
96    :  FORMAT(6I2)
      :  WRITE BINARY(3)IT1,IT2,IT2,ID1,ID2,ID3
      :  WRITE BINARY(4)IT1,IT2,IT3,ID1,ID2,ID3
      :  WRITE BINARY(5)IT1,IT2,IT3,ID1,ID2,ID3
      :  CALL MTDIO(2,0,IBUF,IS,IFER)
      :  CALL MTDIO(2,0,IBUF,IS,IFER)
      :..FIN
```

```
C
C
        TO INIT-VARIABLES
        :   MODE=0
        :   MODE1=2
        :   MAG=1
        :   ICH=1
        :   ND=4
        :..FIN
C
C
        TO ASK-QUESTIONS
        :   TYPE " "
        :   TYPE "THE FOLLOWING FUNCTIONS ARE AVAILABLE, SELECT BY NUMBER"
        :   TYPE " "
        :   TYPE "  1 - READ IMAGE         9 - USE WFM"
        :   TYPE "  2 - ALARM             10 - USE CHCOLR"
        :   TYPE "  3 - MAGNIFY           11 - USE FILTER2"
        :   TYPE "  4 - TRAINING          12 - USE CLYDE5"
        :   TYPE "  5 - GCP"
        :   TYPE "  6 - DIGITIZE"
        :   TYPE "  7 - USE SCRIPTO       98 - BLANK GRAPHICS"
        :   TYPE "  8 - USE INK           99 - STOP"
        :   TYPE " "
        :   ACCEPT "FUNCTION NUMBER ? ",IFUN
        :..FIN
C
C
        TO TAKE-TRAINING-SAMPLE
        :   K=1
        :   ICLOSE=1
        :   PAUSE   POSITION CURSOR FOR TRAINING FIELD  THEN RETURN
        :   CALL GETXY(IXS,IYS)
        :   IXS=IAND(IXS,377K)
        :   IYS=IAND(IYS,377K)
        :   IVX(1)=IXS
        :   IVY(1)=IYS
        :   IXS1=IXS
        :   IYS1=IYS
        :   TYPE " CURSOR COORDS ",IXS,IYS
        :   TYPE "  POSITION CURSOR AT NEXT VERTEX"
        :   ACCEPT "  ENTER 1 TO READ POSITION, 2 TO CLOSE : ",ICLOSE
        :   REPEAT UNTIL (ICLOSE.NE.1)
        :   :   CALL GETXY(IX,IY)
        :   :   CHECK-XY
        :   :   CALL VECTOR(1,IXS,IYS,IX,IY,1,1)     ;DRAW ON GRAPHICS 1
        :   :   TYPE "  END PTS OF SEGMENT",IXS,IYS,IX,IY
        :   :   K=K+1
        :   :   IVX(K)=IX
        :   :   IVY(K)=IY
        :   :   IXS=IX
        :   :   IYS=IY
        :   :   ACCEPT "  ENTER 1 TO READ POSITION , 2 TO CLOSE : ",ICLOSE
        :   :..FIN
        :   CALL VECTOR(1,IXS,IYS,IXS1,IYS1,1,1)
        :   IYMAX=0
        :   IXMAX=0
        :   IXMIN=10000
        :   IYMIN=10000
        :   IVX(K+1)=IVX(1)
        :   IVY(K+1)=IVY(1)
        :   KP=K+1
        :   DO (IR=1,KP)
        :   :   IVX(IR)=IVX(IR)/MAG+ICOL
        :   :   IVY(IR)=IVY(IR)/MAG+IL
        :   :   IF(IVY(IR).GT.IYMAX)IYMAX=IVY(IR)
        :   :   IF(IVY(IR).LT.IYMIN)IYMIN=IVY(IR)
        :   :   IF(IVX(IR).GT.IXMAX)IXMAX=IVX(IR)
        :   :   IF(IVX(IR).LT.IXMIN)IXMIN=IVX(IR)
        :   :..FIN
```

```
      :   ISTART=IYMIN
      :   IEND=IYMAX
      :   TYPE "  BOX LIMITS",ISTART,IEND,IXMIN,IXMAX
      :   CALL RDATA(ISTART,IEND,K,IVX,IVY,IXD,NP)
      :   CALL HIST3B(NP,3)       ;PUT HISTOGRAM ON GRAPHICS 3
      :   ACCEPT "  INPUT 1 FOR STATS : ",ISTAT
25    :   CONTINUE
      :   IF(ISTAT.EQ.1)
      :   :  DO (J1=1,4)
      :   :  :  XM(J1)=0.0
      :   :  :  DO (J2=1,4)
      :   :  :  :  V(J1,J2)=0.0
      :   :  :  :..FIN
      :   :  :..FIN
      :   :  I=0
      :   :  DO (LK=1,NP)
      :   :  :  DO (LJ=1,4)
      :   :  :  :  MX(LJ)=IXD(LK,LJ)
      :   :  :  :..FIN
      :   :  :  TYPE LK
      :   :  :  CALL SEQCOV(MX,4,V,XM,I,D)
      :   :  :..FIN
      :   :  CALL MATPRT(XM,ND,ND,1,5HMEANS)
      :   :  CALL MATPRT(V,ND,ND,ND,3HCOV)
      :   :  TYPE "  STATS CALCULATED FOR ",NP," POINTS"
      :   :  ACCEPT "  DO U WISH TO SAVE THIS SIGNATURE?1=YES : ",ISIG
      :   :  IF(ISIG.EQ.1)
      :   :  :  TYPE "  INPUT 8 CHARACTER NAME FOR SIGNATURE"
      :   :  :  READ(11,107)NA1,NA2,NA3,NA4
107   :   :  :  FORMAT(4A2)
      :   :  :  WRITE BINARY(5)NA1,NA2,NA3,NA4
      :   :  :  WRITE BINARY(5)NP,XM,V
      :   :  :  WRITE BINARY(3)NA1,NA2,NA3,NA4
      :   :  :  WRITE BINARY(3)K,IYMIN,IYMAX
      :   :  :  DO (K1=1,K)WRITE BINARY(3)K1,IVX(K1),IVY(K1)
      :   :  :  WRITE BINARY(4)NA1,NA2,NA3,NA4
      :   :  :  WRITE BINARY(4)ICOUNT
      :   :  :..FIN
      :   :..FIN
      :   ACCEPT "  HAS SIGNATURE BEEN TREATED AS U WISH?1=YES : ",ISAT
      :   IF(ISAT.NE.1)
      :   :  ISTAT=1
      :   :  GO TO 25
      :   :..FIN
      :..FIN
C
C
      TO CLOSE-FILES
      :   CALL FCLOSE(3)
      :   CALL FCLOSE(5)
      :   CALL FCLOSE(4)
      :   STOP TRAIN3 MTU:F    NORMAL EXIT
      :..FIN
C
C
      TO CHECK-MAG-FACTOR
      :   WHILE (MAG.NE.1.AND.MAG.NE.2.AND.MAG.NE.4.AND.MAG.NE.8)
      :   :  TYPE "INCORRECT MAG FACTOR"
      :   :  ACCEPT "ENTER MAG FACTOR (1,2,4, OR 8)",MAG
      :   :..FIN
      :..FIN
```

```
C
C
      TO READ-IMAGE
      :   ILT=IL
      :   ICOLT=ICOL
      :   TYPE "INPUT TOP LEFT COORDS FOR IMAGE (COL,LINE)"
      :   ACCEPT "  ENTER -1,-1 TO KEEP OLD COORDS ",ICOL,IL
      :   IF (IL.EQ.-1)
      :   :   IL=ILT
      :   :   ICOL=ICOLT
      :   :..FIN
      :   ILS=IL
      :   IES=ICOL
      :   ACCEPT "MAGNIFICATION FACTOR (1,2,4, OR 8) ? ",MAG
      :   CHECK-MAG-FACTOR
      :   CALL RDIMG(IL,ICOL,ICH,MAG)
      :..FIN
C
C
      TO ALARM-SCREEN
      :   ACCEPT "ALARM TO WHICH OVERLAY (0-3)  ",IOV
      :   CALL ALRM2(IOV)
      :..FIN
C
C
      TO MAGNIFY-SUBSET-OF-SCREEN
      :   PAUSE POSITION CURSOR AT UPPER LEFT AND HIT RETURN
      :   CALL GETXY(IX,IY)
      :   CHECK-XY
      :   ICOL=IX/MAG+IES
      :   IL=IY/MAG+ILS
      :   TYPE "SCREEN COORDS",IX,IY
      :   TYPE "  TAPE COORDS",ICOL,IL
      :   ACCEPT "MAG FACTOR (1,2,4, OR 8) ? ",MAG
      :   CHECK-MAG-FACTOR
      :   CALL RDIMG(IL,ICOL,ICH,MAG)
      :..FIN
C
C
      TO TAKE-GCP
      :   ACCEPT "INPUT 1 TO READ CURSOR POSITION ",IG
      :   REPEAT UNTIL(IG.NE.1)
      :   :   CALL GETXY(IX,IY)
      :   :   CHECK-XY
      :   :   TYPE "SCREEN COORDS",IX,IY
      :   :   ICOLKT=IX/MAG+ICOL
      :   :   ILKT=IY/MAG+IL
      :   :   TYPE "  TAPE COORDS",ICOLKT,ILKT
      :   :   ACCEPT "INPUT 1 TO READ CURSOR POSITION ",IG
      :   :..FIN
      :..FIN
```

```
C
C
      TO DIGITIZE-BOUNDARY
      :  ACCEPT "DRAW BOUNDARY ON WHICH OVERLAY (0-3) ? ",IOV
      :  PAUSE   POSITION CURSOR AT START AND HIT RETURN
      :  CALL GETXY( IX, IY)
      :  CHECK-XY
      :  TYPE "SCREEN COORDS", IX, IY
      :  ICOLS= IX/MAG+ ICOL
      :  ILS2= IY/MAG+ IL
      :  TYPE "   TAPE COORDS", ICOLS, ILS2
      :  IX1= IX
      :  IY1= IY
      :  IXS= IX
      :  IYS= IY
      :  ACCEPT "ENTER: 1 TO READ POSITION, 2 TO CLOSE, 3 TO STOP ",ICLOSE
      :  REPEAT UNTIL( ICLOSE.NE. 1)
      :  :  CALL GETXY( IX, IY)
      :  :  CHECK-XY
      :  :  CALL VECTOR( IOV, IXS, IYS, IX, IY, 1, 1)
      :  :  TYPE "LAST VERTEX AT"
      :  :  TYPE "      SCREEN COORDS", IX, IY
      :  :  ICOLS= IX/MAG+ ICOL
      :  :  ILS2= IY/MAG+ IL
      :  :  TYPE "        TAPE COORDS", ICOLS, ILS2
      :  :  IXS= IX
      :  :  IYS= IY
      :  :  ACCEPT "ENTER: 1 TO READ POSITION, 2 TO CLOSE, 3 TO STOP ",ICI
      :  :..FIN
      :  IF ( ICLOSE.EQ.2) CALL VECTOR( IOV, IXS, IYS, IX1, IY1, 1, 1)
      :..FIN
C
C
      TO CHECK-XY
      :  IX= IAND( IX,377K)
      :  IY= IAND( IY,377K)
      :..FIN
C
C
      TO BLANK-GRAPHICS
      :  ACCEPT "WHICH OVERLAY TO BLANK ? (0-3)  ",IGRN
      :  DO ( I=1,16)  IDUM( I)=0
      :  DO ( I=0,255) CALL GWR( IGRN, I, IDUM, 16)
      :..FIN
C
C
      STOP
      END
```

```
C***************************************************************************
C                                                                          *
C        UNPAC1    (SUBROUTINE)                                            *
C                                                                          *
C        UNPACKS LANDSAT GODDARD FORMAT                                    *
C                                                                          *
C***************************************************************************
C                                                                          *
C       "CREATED AT NASA/JSC    (ASTEP)                                    *
C                                                                          *
C***************************************************************************
         SUBROUTINE UNPAC1
         INTEGER BUF
         COMMON/BUFFER/BUF(3300)
         COMMON/COL/JS,JF
         CALL MTDIO(4,0,BUF,ISTAT,IERR,NW)
         IF(NW.GT.1750)WRITE(10,1)
         WRITE(10,2)NW
2        FORMAT(2X,"# OF WORDS READ =  ",I5)
1        FORMAT(2X,"ERROR IN UNPAC1")
         IM=1630
         JC=0
         DO 20 I=1,NW
         NM=I+IM
20       BUF(NM)=BUF(I)
         DO 3 J=JS,JF
         I=J-1
         L1=-16+(I+(I/2)*6)*8
         JC=JC+1
         DO 4 I=1,4
         IL=L1+I*16
         II=IL/16
         I2=IABS(IL-II*16)
         II=II+1
         IF(I2.EQ.8)GO TO 10
         II=ISHFT(BUF(II+IM),-8)
         GO TO 5
10       CONTINUE
         II=IAND(BUF(II+IM),377K)
5        CONTINUE
         KK=I+(JC-1)*4
         BUF(KK)=255-II
4        CONTINUE
3        CONTINUE
         RETURN
         END
```

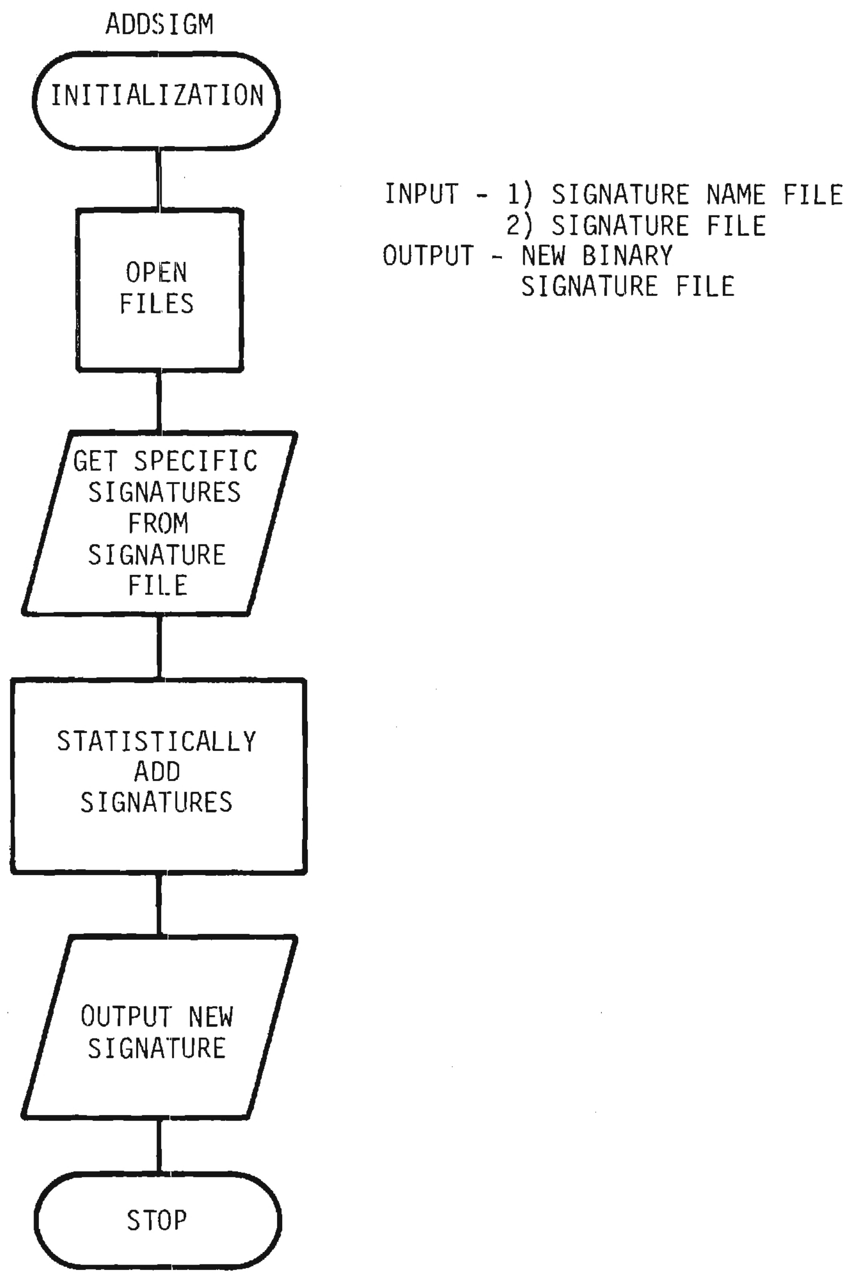
```
C***************************************************************************
C                                                                          *
C       UNPAC4  (SUBROUTINE)                                               *
C                                                                          *
C       UNPACKS PART OF LINE INSIDE POLYGON                                *
C                                                                          *
C***************************************************************************
C                                                                          *
C       CREATED AT GEORGIA TECH EES                                        *
C                                                                          *
C       PROGRAMMER:  NICKOLAS L. FAUST                                     *
C                                                                          *
C***************************************************************************
      SUBROUTINE UNPAC4(IBUF,JBUF,JL,JR,N,M)
      DIMENSION JBUF(4,N),IBUF(M)
      IF(JR.GT.810)JR=810
      DO (K=1,4)
      :  L=((JL-1)/2)*4+K
      :  LAST=L+(JR-JL+1)*2
      :  J1=1
      :  DO (I=L,LAST,4)
      :  :  JBUF(K,J1)=ISHFT(IBUF(I),-8)
      :  :  JBUF(K,J1+1)=IAND(IBUF(I),377K)
      :  :  J1=J1+2
      :  :..FIN
      :..FIN
      RETURN
      END
```

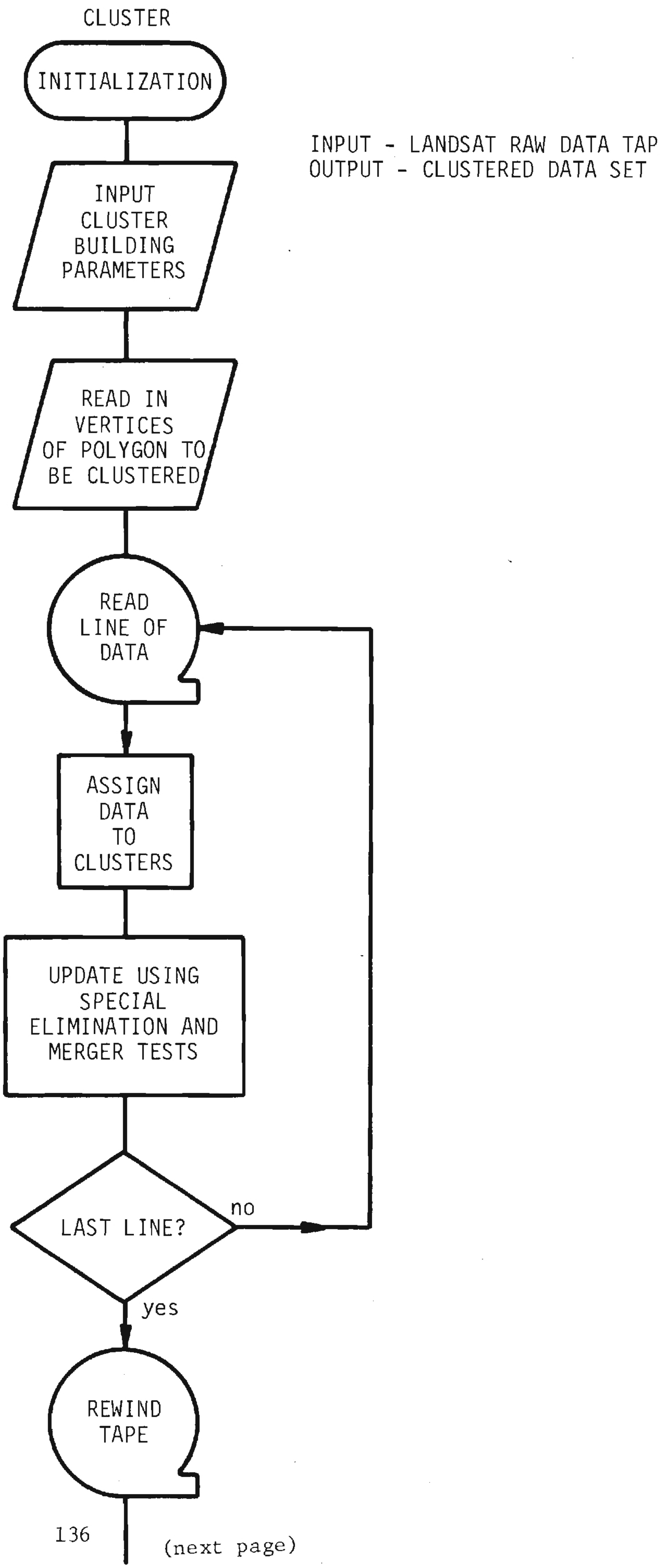
```
C*******************************************************************************
C                                                                              :
C         UPPLT   (SUBROUTINE)                                                 :
C                                                                              :
C     PURPOSE                                                                  :
C              GENERATES PRIORITY LIST GIVEN WEIGHTS                           :
C                                                                              :
C     DESCRIPTION OF PARAMETERS                                                :
C                                                                              :
C         INPUT                                                                *
C           CALLING SEQUENCE                                                   *
C              NVG - WEIGHTS, I-TH VALUE IS NUMBER OF POINTS IN I-TH           *
C                    CLUSTER                                                   *
C              NVM - NUMBER OF ENTRIES IN NVG                                  *
C                                                                              *
C         OUTPUT                                                               *
C           CALLING SEQUENCE                                                   *
C              PLIST - PRIORITY LIST, J-TH VALUE IS INDEX OF THE J-TH          *
C                      LARGEST ENTRY IN NVG                                    *
C                                                                              *
C*******************************************************************************
C                                                                              *
C         CREATED AT NASA/JSC   (ASTEP)                                        *
C                                                                              *
C*******************************************************************************
      SUBROUTINE UPPLT(PLIST,NVG,NVM)
      REAL NVG,N
      INTEGER PLIST,TLIST
      DIMENSION PLIST(NVM),NVG(NVM),TLIST(20)
      DO 10 I=1,20
   10 TLIST(I)=0
      DO 30 L=1,NVM
      N=-1
      DO 20 I=1,NVM
      IF(TLIST(I).EQ.1) GO TO 20
      IF(NVG(I).LE.N) GO TO 20
      N=NVG(I)
      J=I
   20 CONTINUE
      TLIST(J)=1
   30 PLIST(L)=J
      RETURN
      END
```

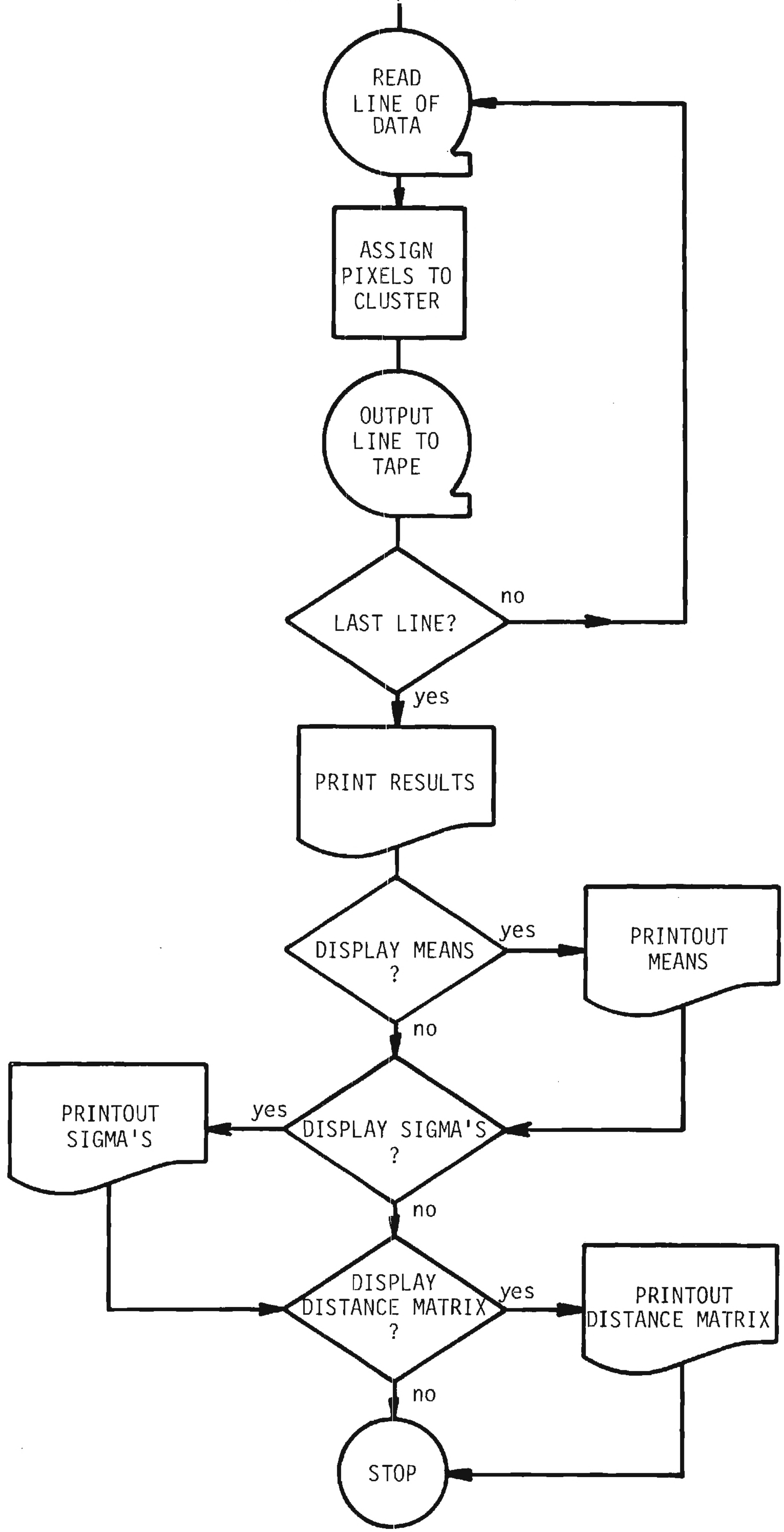
```
C***********************************************************************
C                                                                      *
C       ZCOUNTY                                                        *
C                                                                      *
C        CALCULATES PIXEL COORDINATES FOR ANY COUNTY PARTIALLY         *
C        OR WHOLLY CONTAINED IN A SCENE AND WRITES RESULTS TO DISK.    *
C                                                                      *
C        SEQUENCE:  NCOUNTY TAPE FILE                                  *
C                                                                      *
C***********************************************************************
C                                                                      *
C        CREATED AT GEORGIA TECH EES                                   *
C                                                                      *
C        PROGRAMMER:  NICKOLAS L. FAUST                                *
C                                                                      *
C***********************************************************************
      DIMENSION NCODE(50),ITEMP(2,300),FIELD(17),ISWS(2)
      COMMON/DUM/IA(4100)
      CALL OPEN(1,"COM.CM",1,IERR)
      CALL COMARG(1,FIELD,ISWS,IER)
      CALL COMARG(1,FIELD,ISWS,IER)
      CALL MTOPD(2,FIELD,0,IE)
      CALL COMARG(1,FIELD,ISWS,IER)
      CALL FOPEN(3,FIELD,0,IE)
      ISET=1
      IOU=3
      NCOD=0
      ACCEPT "A1,A2,A3,B1,B2,B3 ",A1,A2,A3,B1,B2,B3
      ACCEPT "SKIP RECORDS? ",ISK
      IF (ISK.GT.0)
      :  DO (I=1,ISK) CALL MTDIO(2,0,IA,IS,IE,IC)
      :..FIN
      K=0
      IV=0
      IC=10
      UNTIL (IC.LT.5)
      :  CALL MTDIO(2,0,IA,IS,IE,IC)
      :  TYPE " DATA ",(IA(KK),KK=1,IC)
      :  NCOUNTY=IA(1)
      :  YI=IA(2)*10000.+IA(3)
      :  XI=IA(4)*10000.+IA(5)
      :  IF(XI.LE..001.AND.YI.LE..001)STOP
      :  IV=IV+1
      :  IF(NCOUNTY.NE.NCOD)
      :  :  ISET=1
      :  :  JSET=0
      :  :  KSET=0
      :  :  IF(K.NE.0)
      :  :  :  NIV=IV-1
      :  :  :  DO (J=1,NIV)
      :  :  :  :  IF(ITEMP(1,J).GT.0.AND.ITEMP(1,J).LT.4000)JSET=1
      :  :  :  :  IF(ITEMP(2,J).GT.0.AND.ITEMP(2,J).LT.4000)KSET=1
      :  :  :  :  IF(JSET.EQ.1.AND.KSET.EQ.1)ISET=0
      :  :  :  :  JSET=0
      :  :  :  :  KSET=0
      :  :  :  :..FIN
      :  :  :  IF(ISET.EQ.0)
      :  :  :  :  NIV=IV-1
      :  :  :  :  IV=1
      :  :  :  :  WRITE(IOU)NCOD
      :  :  :  :  WRITE(IOU)NIV
      :  :  :  :  DO (K1=1,NIV)WRITE(IOU,200)ITEMP(1,K1),ITEMP(2,K1)
200   :  :  :  :  FORMAT(1X,2I5)
      :  :  :  :  WRITE(IOU,300)NCOD
300   :  :  :  :  FORMAT(2X," END OF PIXELS FOR COUNTY = ",I5)
      :  :  :  :..FIN
      :  :  :..FIN
      :  :  IV=1
      :  :  NCOD=NCOUNTY
      :  :  K=1
      :  :  ISET=1
      :  :..FIN
      :  PY=A1+A2*XI+A3*YI
      :  PX=B1+B2*XI+B3*YI
      :  ITEMP(1,IV)=PX
      :  ITEMP(2,IV)=PY
      :..FIN
      STOP
      END
```

APPENDIX C

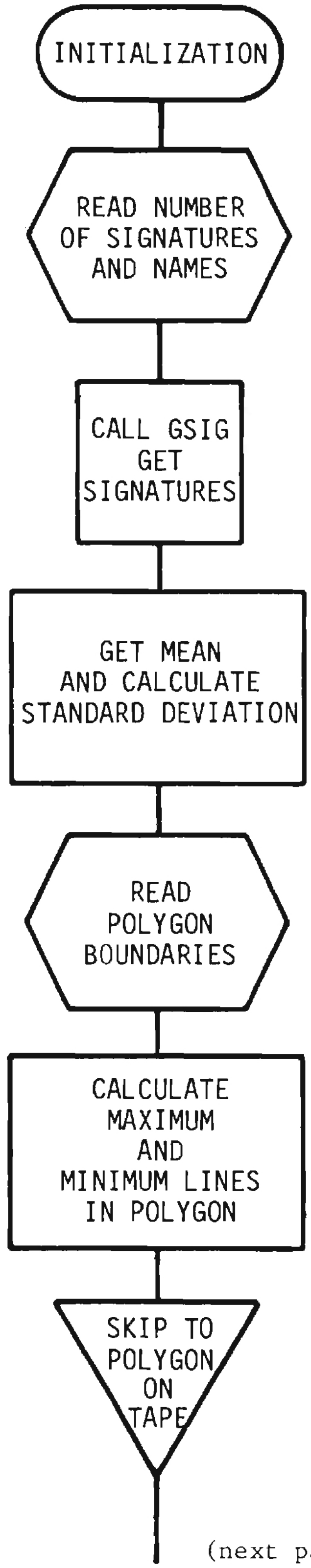
MAIN PROGRAM FLOWCHARTS


ADDSIGM
INITIALIZATION
OPEN FILES
GET SPECIFIC SIGNATURES FROM SIGNATURE FILE
STATISTICALLY ADD SIGNATURES
OUTPUT NEW SIGNATURE
STOP
INPUT - 1) SIGNATURE NAME FILE
2) SIGNATURE FILE
OUTPUT - NEW BINARY SIGNATURE FILE


CLUSTER
INITIALIZATION
INPUT - LANDSAT RAW DATA TAPE
OUTPUT - CLUSTERED DATA SET
INPUT CLUSTER BUILDING PARAMETERS
READ IN VERTICES OF POLYGON TO BE CLUSTERED
READ LINE OF DATA
ASSIGN DATA TO CLUSTERS
UPDATE USING SPECIAL ELIMINATION AND MERGER TESTS
LAST LINE?
no
yes
REWIND TAPE
(next page)

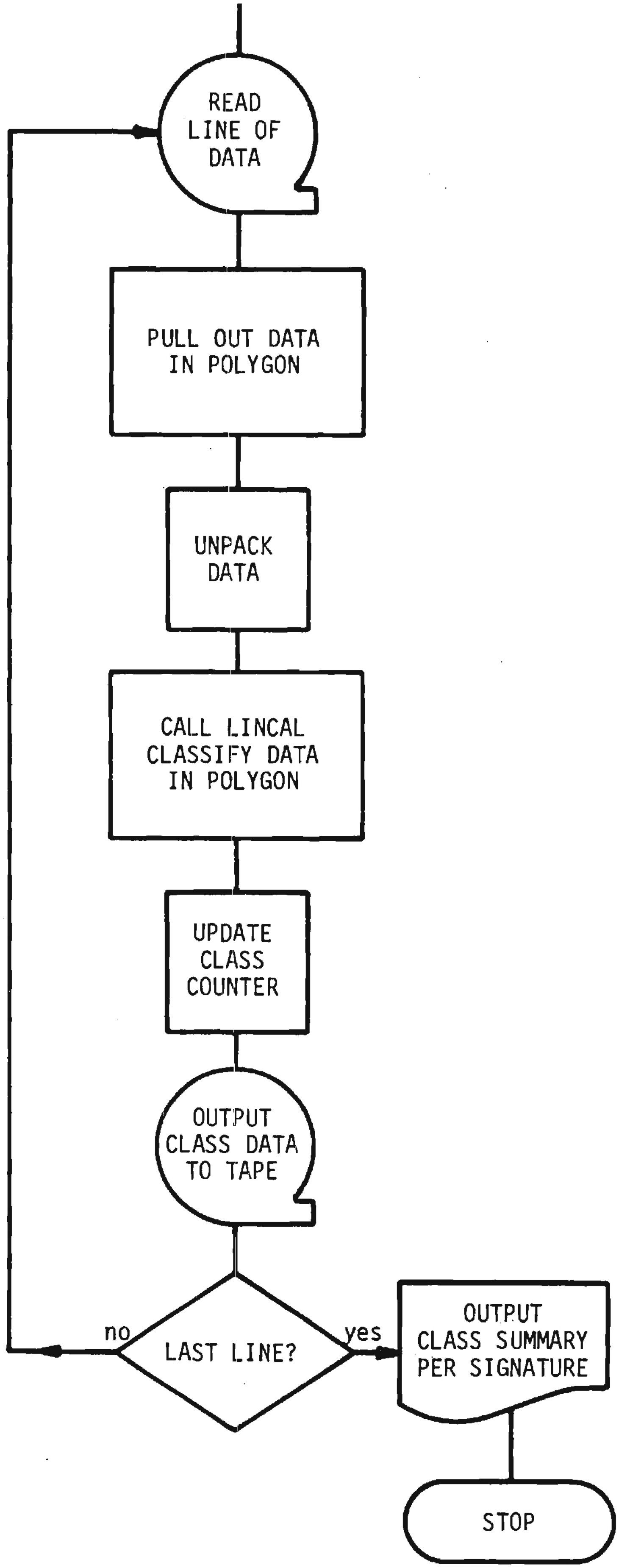

READ LINE OF DATA
ASSIGN PIXELS TO CLUSTER
OUTPUT LINE TO TAPE
LAST LINE?
no
yes
PRINT RESULTS
DISPLAY MEANS ?
yes
PRINTOUT MEANS
no
DISPLAY SIGMA'S ?
yes
PRINTOUT SIGMA'S
no
DISPLAY DISTANCE MATRIX ?
yes
PRINTOUT DISTANCE MATRIX
no
STOP

LINCLASS

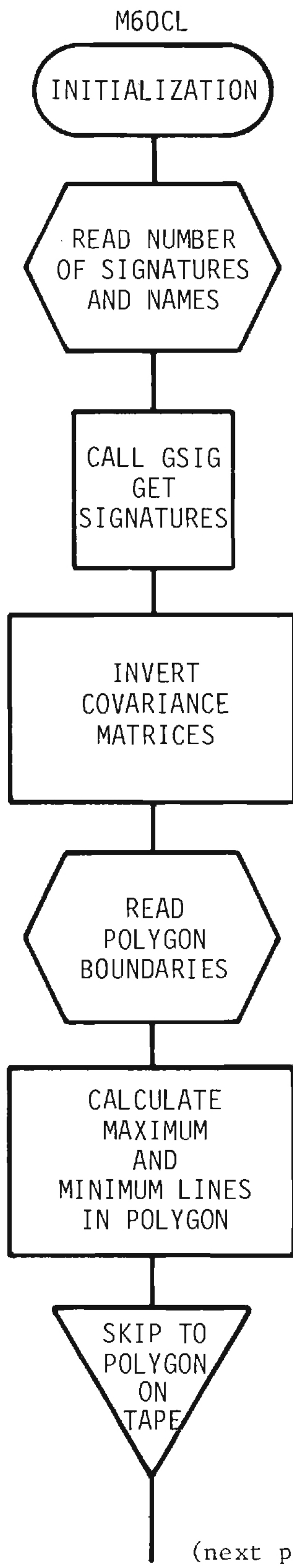


INPUT - LANDSAT RAW DATA TAPE
OUTPUT - CLASSIFIED DATA TAPE

(next page)

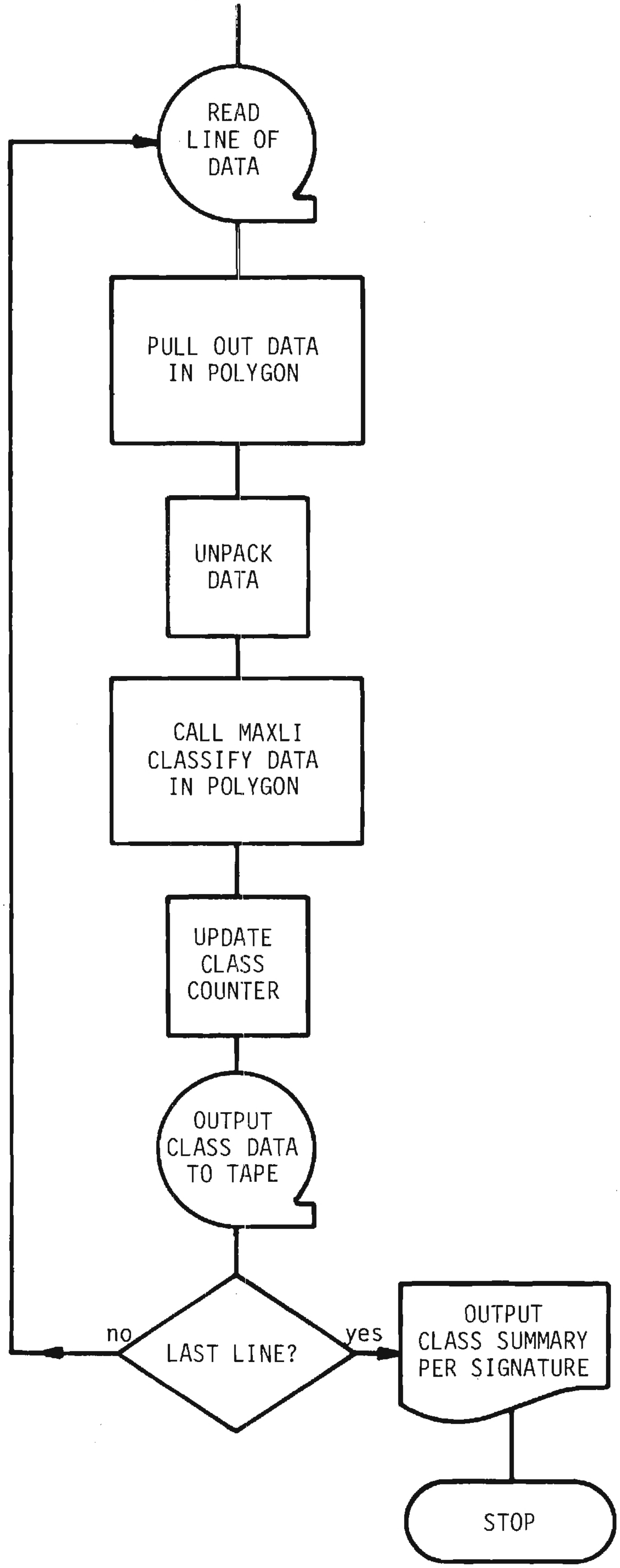

READ LINE OF DATA
PULL OUT DATA IN POLYGON
UNPACK DATA
CALL LINCAL CLASSIFY DATA IN POLYGON
UPDATE CLASS COUNTER
OUTPUT CLASS DATA TO TAPE
LAST LINE?
no
yes
OUTPUT CLASS SUMMARY PER SIGNATURE
STOP

INPUT - LANDSAT RAW DATA TAPE
OUTPUT - CLASSIFIED DATA TAPE

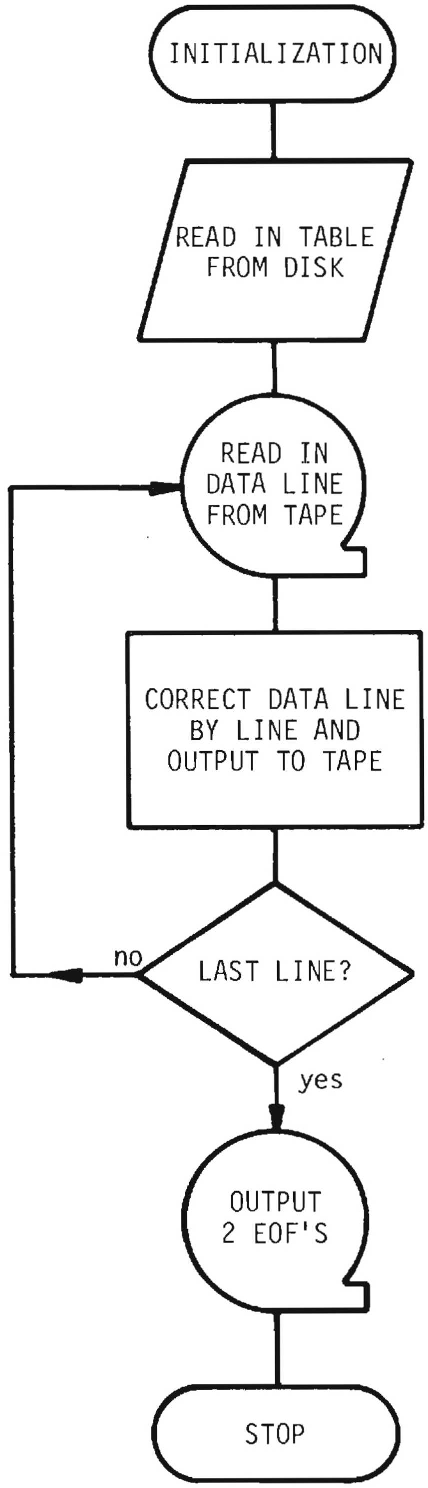


(next page)

M60CL (Continued)

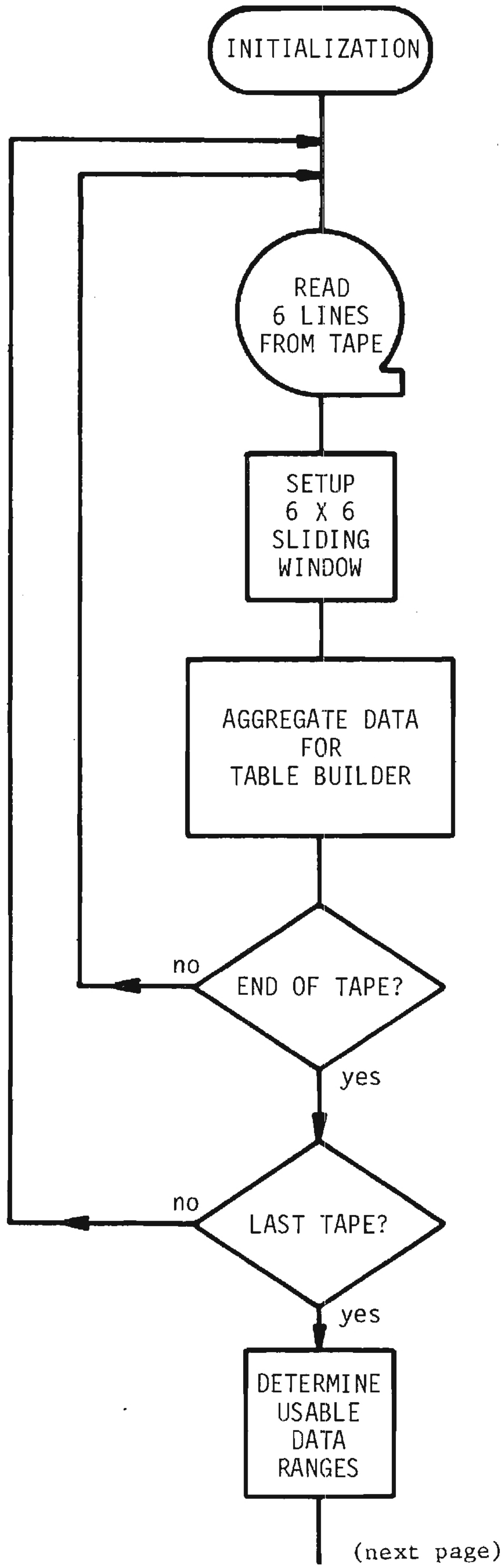


STRIPLESS



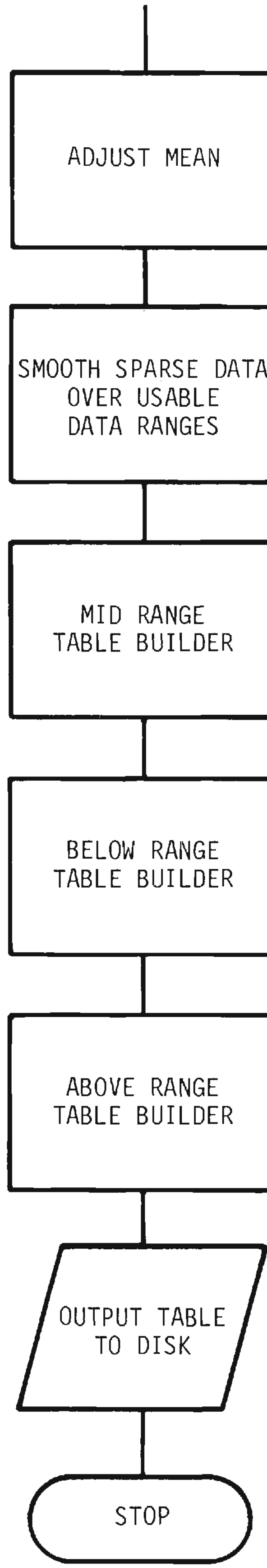
INPUT - DISK FILE
OUTPUT - DATA TAPE

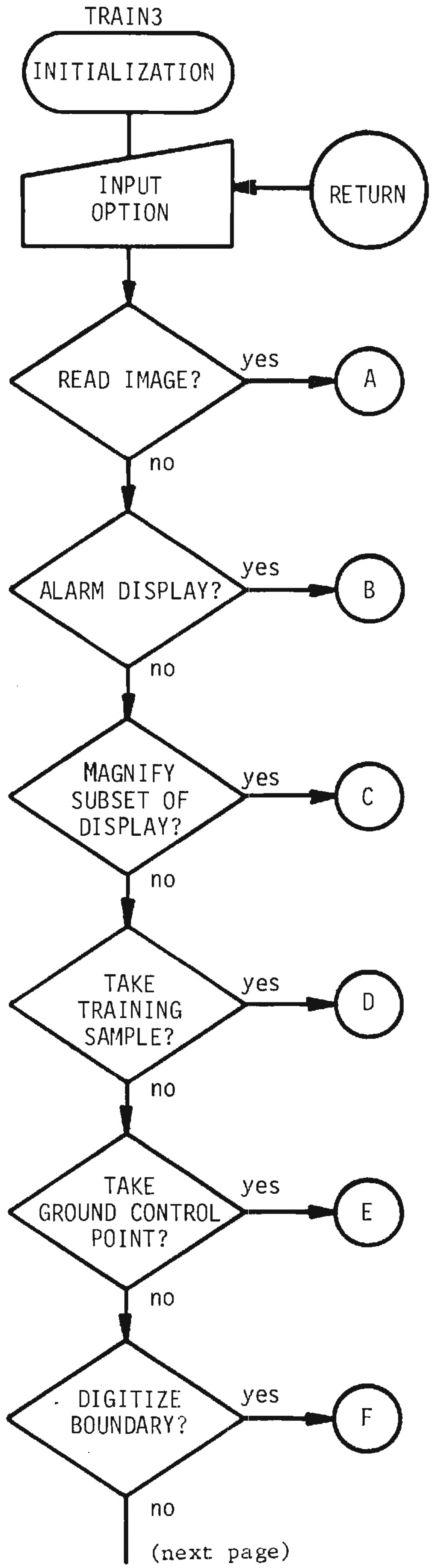
STRIPNF



INPUT - LANDSAT RAW DATA TAPE
OUTPUT - DISK FILE AND PRINTER

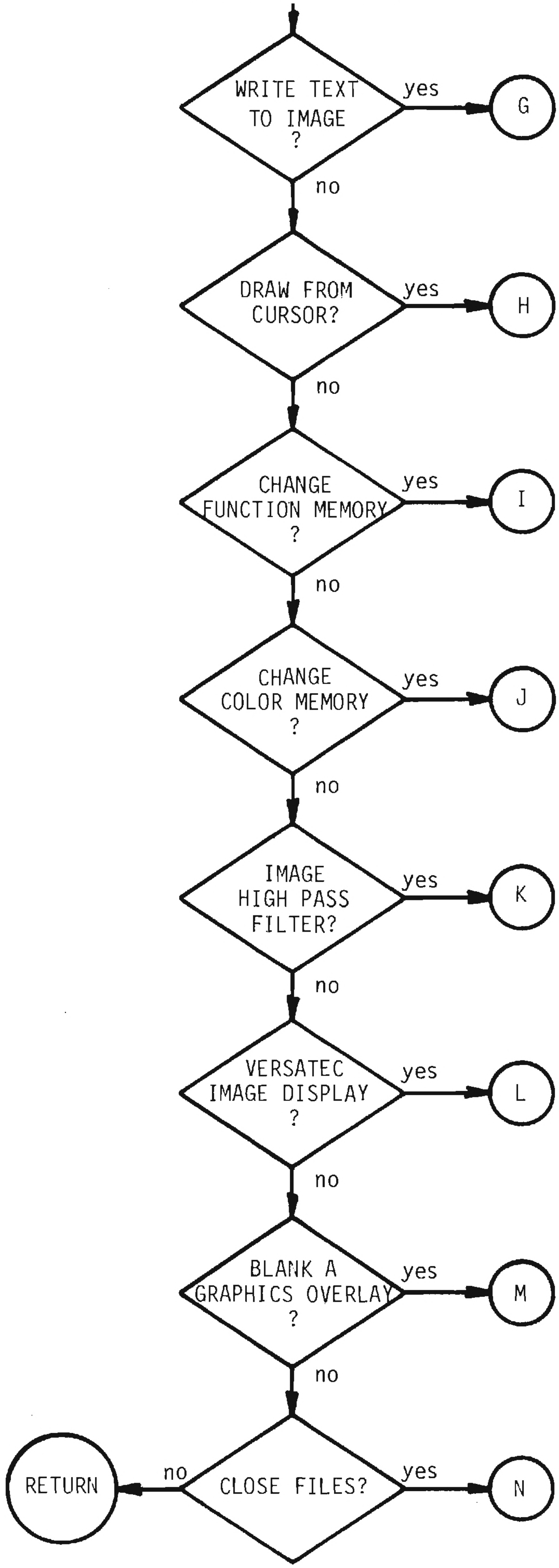
STRIPNF (Continued)

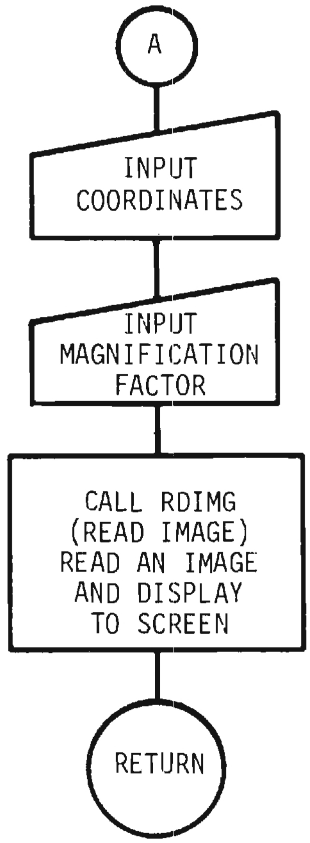


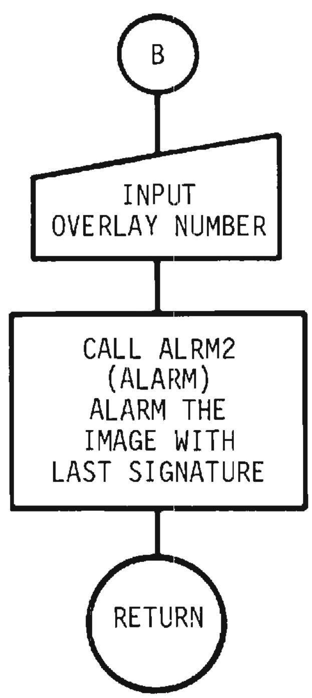


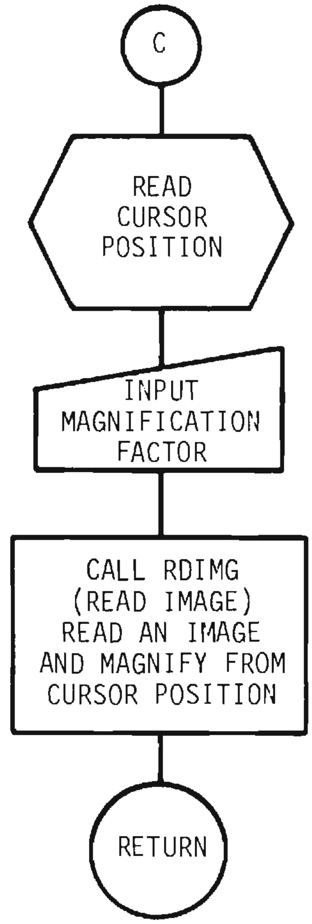
INPUT - LANDSAT RAW DATA TAPE
OUTPUT - FILES FOR
a) SIGNATURES
b) VERTICES
c) HISTOGRAMS

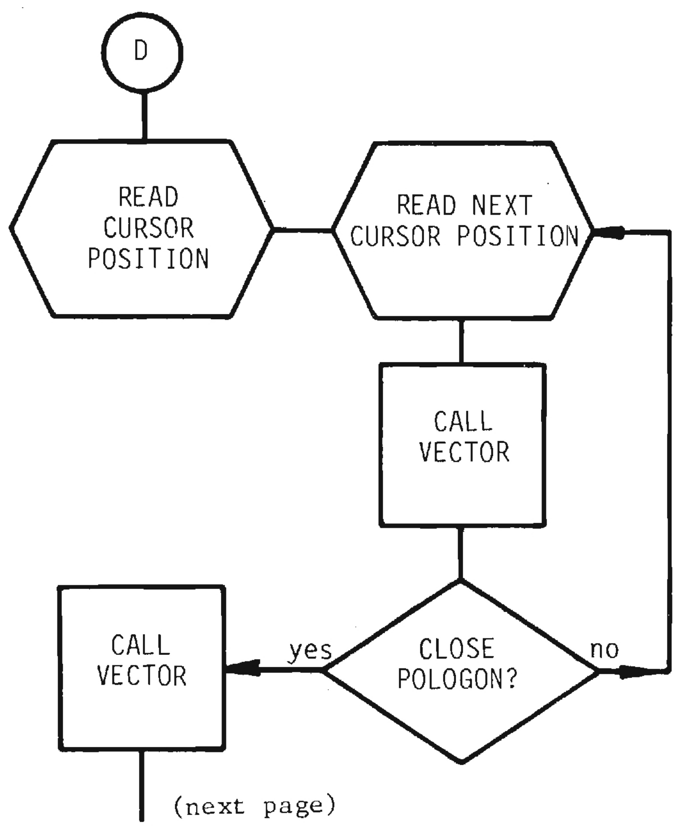
TRAIN3 (Continued)



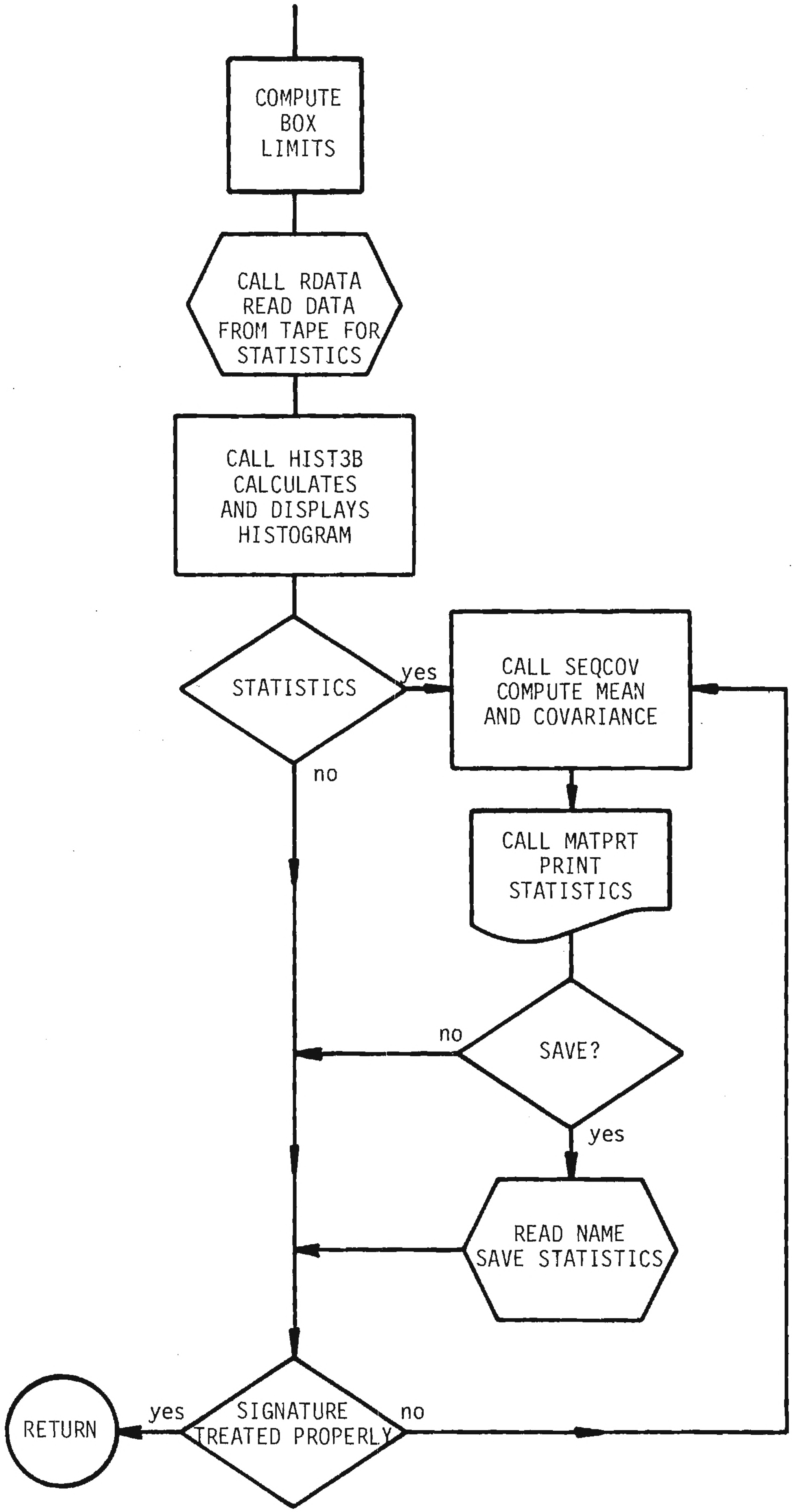

A
INPUT COORDINATES
INPUT MAGNIFICATION FACTOR
CALL RDIMG (READ IMAGE) READ AN IMAGE AND DISPLAY TO SCREEN
RETURN


B
INPUT OVERLAY NUMBER
CALL ALRM2 (ALARM) ALARM THE IMAGE WITH LAST SIGNATURE
RETURN

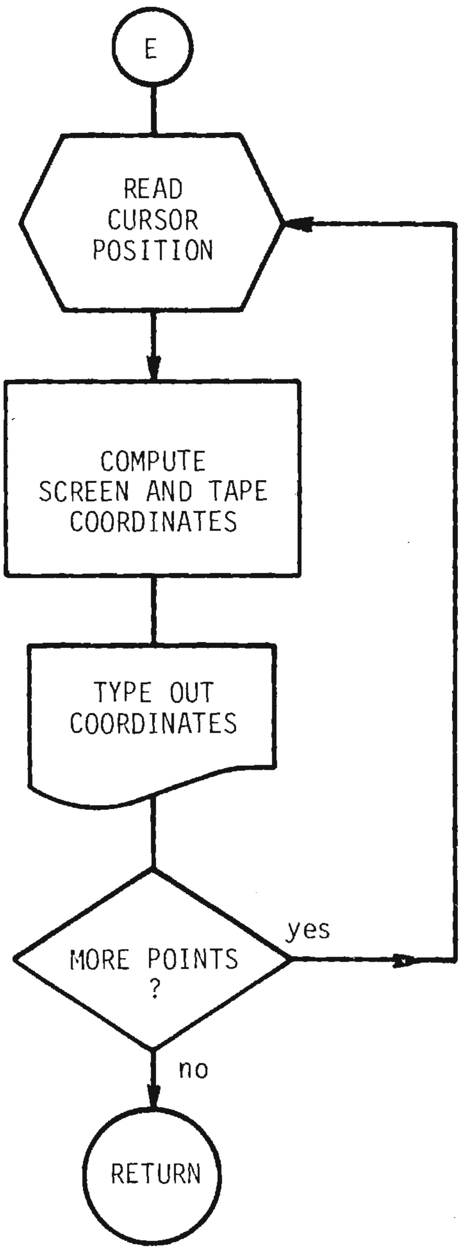

C
READ CURSOR POSITION
INPUT MAGNIFICATION FACTOR
CALL RDIMG (READ IMAGE) READ AN IMAGE AND MAGNIFY FROM CURSOR POSITION
RETURN

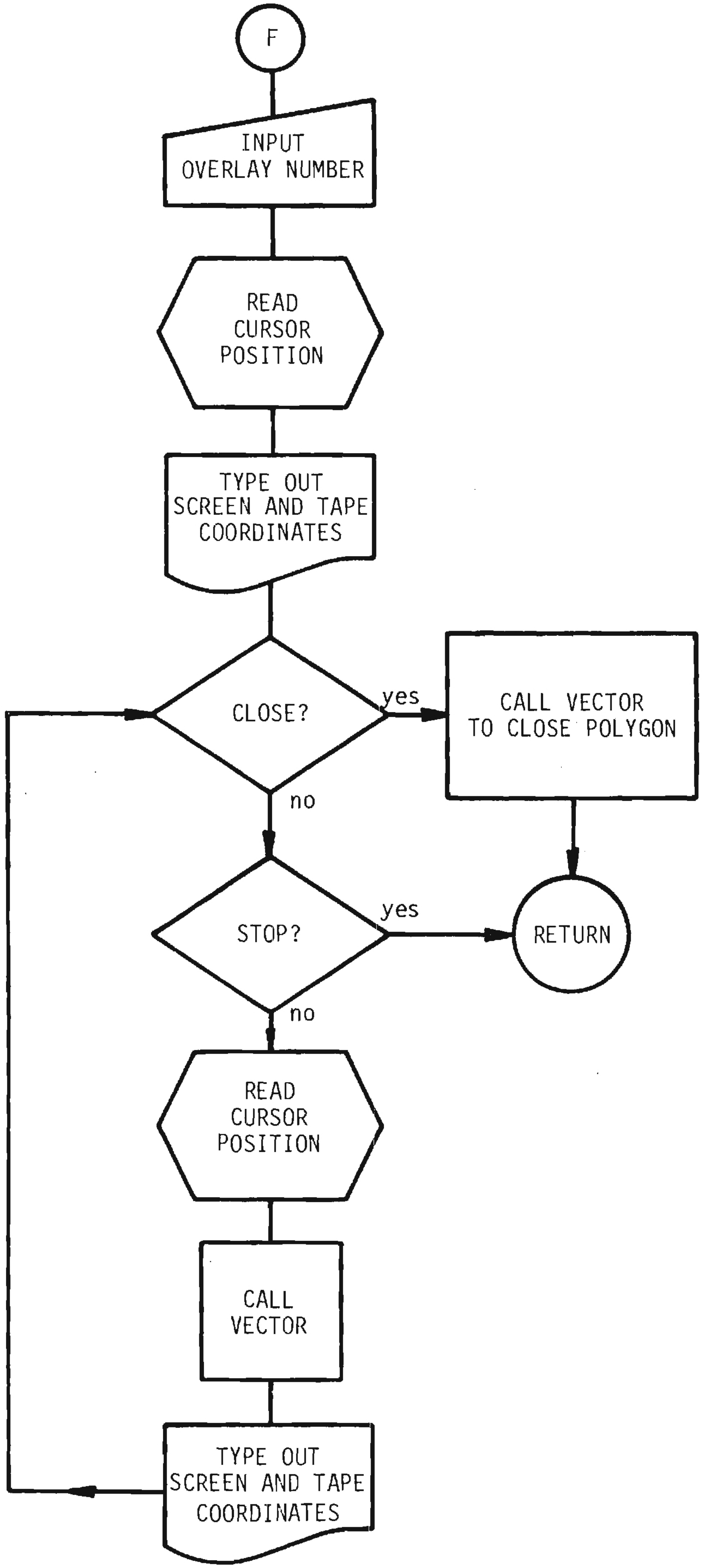

D
READ CURSOR POSITION
READ NEXT CURSOR POSITION
CALL VECTOR
CLOSE POLOGON?
yes
no
CALL VECTOR

(next page)

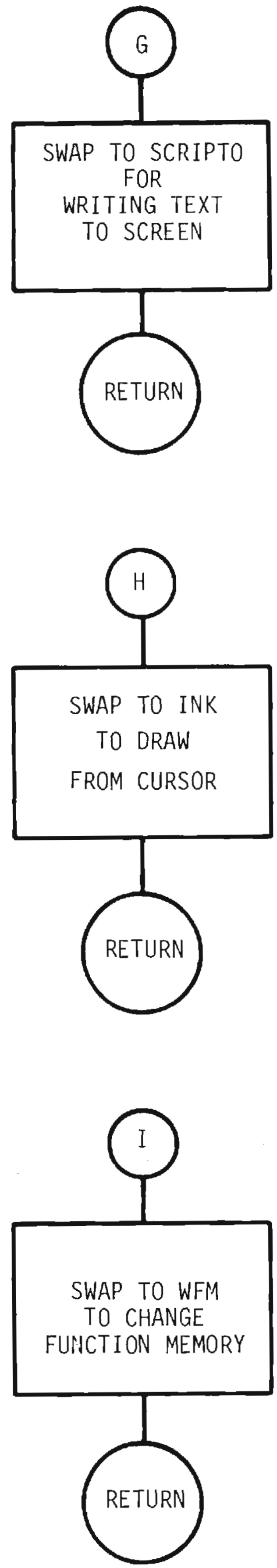

COMPUTE BOX LIMITS
CALL RDATA READ DATA FROM TAPE FOR STATISTICS
CALL HIST3B CALCULATES AND DISPLAYS HISTOGRAM
STATISTICS
yes
no
CALL SEQCOV COMPUTE MEAN AND COVARIANCE
CALL MATPRT PRINT STATISTICS
SAVE?
no
yes
READ NAME SAVE STATISTICS
SIGNATURE TREATED PROPERLY
yes
no
RETURN

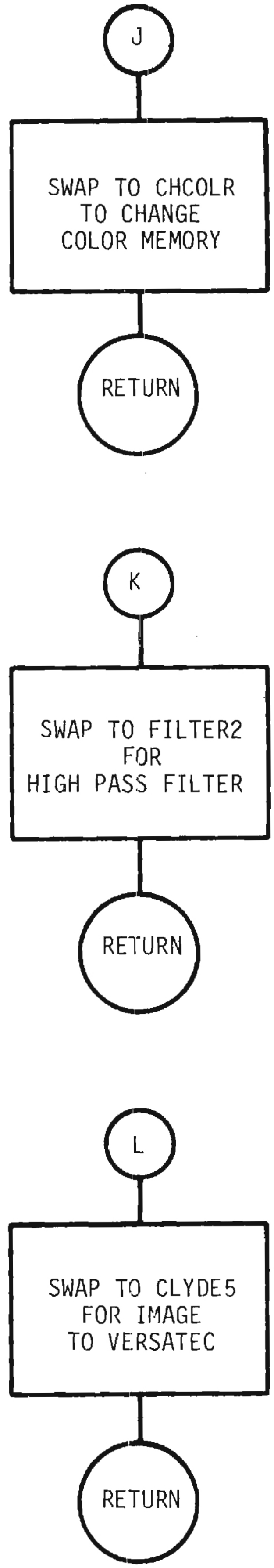
TRAIN3 (Continued)




F
INPUT
OVERLAY NUMBER
READ
CURSOR
POSITION
TYPE OUT
SCREEN AND TAPE
COORDINATES
CLOSE?
yes
CALL VECTOR
TO CLOSE POLYGON
no
STOP?
yes
RETURN
no
READ
CURSOR
POSITION
CALL
VECTOR
TYPE OUT
SCREEN AND TAPE
COORDINATES

TRAIN3 (Continued)




J
SWAP TO CHCOLR TO CHANGE COLOR MEMORY
RETURN
K
SWAP TO FILTER2 FOR HIGH PASS FILTER
RETURN
L
SWAP TO CLYDE5 FOR IMAGE TO VERSATEC
RETURN

TRAIN3 (Continued)